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The contribution of achievement goal orientation to task-related classroom behaviour

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A Thesis submitted to the University of Sussex

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Declaration

I hereby declare that this thesis has not been, and will not be, submitted in whole or in part to another university for the award of any other degree.

Signed

Date

Dedication

For Patty

Acknowledgements

“..... always there will be greater and lesser persons than yourself. Enjoy your achievements as well as your plans.” (Desiderata, M. Ehrmann, circa 1920)

Thanks and gratitude must go to my supervisors; Nicola Yuill for her support, guidance, invaluable advice, comments, endless patience and confidence when I had none. Without which this thesis would not have been completed. Thanks to Amanda Carr for her helpful comments, valuable time and sensible advice on so many things, not least, not to underestimate the journey! Also for allowing me to support with data collection, without which this thesis would not even have started.

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“sometimes you're ahead, sometimes you're behind...the race is long, and in the end, it's only with yourself.” (Lurhmann, 1997)

UNIVERSITY OF SUSSEX

Victoria Mary Bonnett
For the degree of Master of Philosophy

The contribution of achievement goal orientation to task-related classroom behaviour

This thesis investigates the influence of achievement goal orientation (AGO) on task-related classroom behaviour. The two different orientations suggested within a dichotomous AGO framework influence how children approach, plan and monitor their learning.

Paper 1- Seek, ignore or avoid: How achievement goal orientation influences children's help-seeking during an interactive science task.

This study extends previous research into AGO and children's help-seeking by investigating information gathering, help-seeking and post-help behaviour throughout a classroom-based task.

Sixty-four primary school children (mean age 9yrs, 6 mths) took part in the studies using science based educational software. We hypothesise that children differ in their help-seeking behaviour according to their AGO and that metacognitive support will help reduce these differences.

Results are consistent with the idea that performance-oriented children select higher levels of help than mastery-oriented children. Performance-oriented children appear more reluctant to choose challenging tasks if a successful outcome is uncertain. Our second study reduces these differences and post-test results indicate that carefully providing feedback and embedding metacognitive support is useful in reducing differences between AGO groups.

Paper 2- Maths, Mastery and Metacognition: How adding a creative approach can support children in maths.

We hypothesise that using creativity to support a mastery-oriented approach within a mathematics curriculum encourages metacognition, improves motivation and persistence and helps children achieve an underlying understanding of mathematical concepts thus improving mathematics performance. This paper reports an eleven week project aiming to embed problem-solving strategies within a mastery-oriented whole-class environment to promote exploration, collaboration and a focus on the process of

problem-solving. Participants were 24 children from a rural primary school in East Sussex, 12 boys and 12 girls (mean age 8 years and 9 months). The intervention led to increases in girls' perceived competence and motivation for mathematics and increased metacognitive reflection on learning strategies.

1.0 The contribution of achievement goal orientation to task-related classroom behaviour

Achievement goal orientation (AGO) is a well-documented construct which provides a useful and comprehensive framework to investigate motivations for learning. As well as providing insight into children's focus and motivation when gaining competence, AGO can also lead to insight into children's attributions for success and failure. How children view their success or failure, and the part they played in this, can influence how children approach their next task. An AGO framework therefore also has important implications when trying to understand how best to support children to learn to their full potential. AGO highlights significant differences in the way children recognise and use learning strategies such as help-seeking.

All children learn within the classroom to some degree regardless of their AGO. However, whether a child is motivated to improve their competence or prove their ability by comparing themselves with peers interacts with how a child plans, monitors and progresses through a task and in turn with how they cope with and select challenge. This thesis seeks to investigate the different motivations behind help-seeking according to AGO and then looks further into ways to support children, either individually or within a whole class environment.

Research for this thesis has been achieved through first hand data collection in schools as well as a research journal search using Web of Knowledge, PsycInfo, PsycArticles and Science Direct. The data set used in Paper 1 is part of a larger data set from the E Goals project, which was funded by the UK's EPSRC grant number EP/F018495/. The E Goals project is a collaboration with Nicola Yuill (University of Sussex), Amanda Carr (Canterbury Christ's Church University) and Rose Luckin and

Katerina Avramides (London Knowledge Lab.) An E Goals paper which I am also involved with as part of this data set is Harris, Bonnett, Luckin, Yuill & Avramides (2009).

The literature review will present three main areas of research; firstly, the background, development and application of an AGO framework, secondly, how this may be relevant to children's help-seeking and thirdly how this framework may be applicable within a classroom context.

2.0 Achievement Goal Orientation

2.1 Background

Traditionally, AGO focuses on a dichotomous framework of motivation which can provide some insight into how children evaluate their learning and associated ability. Nicholls (1984) identified a "differentiated conception of ability" and suggested that the manner in which tasks are presented, such as the degree of competition emphasised within the task, makes different motivation for effort salient between students. For example, presenting a work sheet as a test may lead to children focusing on the end result whereas presenting a work sheet as a learning task may ensure children focus on understanding and are willing to spend more effort doing so. Nicholls (1984) suggested that the purpose, or motivation, of every individual is to either demonstrate high ability, or to avoid demonstrating low ability. However, how ability is evaluated depends on the individual's conception of ability and it this conception of ability which then leads onto differentiated motivation between students.

In his review of the literature, Nicholl's (1984) described two views of ability; one view as a "capacity", you either have it or you don't, which Nicholl's refers to as ego- involvement. The second view, referred to as task-involvement, is an incremental

ability which can be increased with further effort. Ego-involvement includes an evaluation of one's own ability, comparative to others and any personal effort towards a task is judged against effort made by others completing the same task. Improved competence may not be enough for an ego-involved child to evaluate their own ability, they also need to know how their peers are doing in the same task and the level of effort their peers are making (Nicholls, 1984). In comparison, children holding a task-involvement motivation view tasks that demand little effort as offering little opportunity to demonstrate ability. These children consider applying effort as an integral part of the learning process and an important aspect of an ability evaluation. For children holding a task-involvement motivation, improving competence through effort is a useful indication of ability (Nicholls, 1984).

Following on from the idea that task presentation can enhance different motivations depending on the task focus, Ames (1984) investigated how the structure of an achievement setting can influence how children view their achievement. Ames (1984) used different terminology to Nicholls (1984) in order to define a dichotomous framework. Ames (1984) used the term "helpless" rather than ego-involved to describe children who made internal attributions for failure such as not being clever enough to complete the task. Ames (1984) used the term mastery-oriented rather than task-involved to describe children who attribute failure to lack of effort. Ames (1984), randomly assigned children to either a competitive or individual condition designed to elicit either helpless responses or mastery-oriented responses. Children were assigned a range of solvable and unsolvable puzzles to work on. Children in the competitive category were encouraged to *"solve the most"* and *"see who the winner is"* whilst children in the individual category were encouraged to *"solve as many as you*

can” and *“more than you did before”* (Ames, 1984). Children in the competitive condition focused more on their ability, *“was I smart?”* and made more ability attributions *“I am good at these”*, whereas children in the individual condition used more self-instructions such as *“I will make a plan”* and linked effort more saliently to outcome. This research agrees with Nicholls’s (1984) assertion that the manner in which tasks are presented increases the salience of different motivations for a child, but assessing the structure of an achievement setting places the motivation solely within the context of the situation rather than individual internal motivations for learning. Ames (1984) put children in pairs for the competitive condition and individually for the mastery instructions. It might also have been interesting to give children working individually competitive instructions and children working in pairs the more mastery focused instructions to also gauge how influential working alongside a peer may be.

A child’s view of ability and motivation for particular tasks is also affected by their perception of their existing ability as either high or low. For children holding a task-involvement orientation, perceiving ability as either high or low will not make a huge difference: effort will still lead to improvement in competence. For children with an ego-involvement focus, perceived ability will influence task choice and the amount of effort a child is willing to make (Nicholls, 1984). Nicholls (1984) proposed that an ego-involvement, coupled with low perceived ability, will lead to a child selecting easier tasks where success is guaranteed, therefore leaving the child with a perception of competence. For example, a child who has an ego involvement focus and low perceived ability will view that ability as fixed and will feel unable to improve upon it even with further effort. Therefore, if the child chooses an easier task which they can complete with success, the child will still feel some competence, even though they

may not have progressed in knowledge or understanding. Ego-involved children with a high perceived level of ability also believe that this is fixed and cannot necessarily be eroded by failure; for these children task choice is less dependent on perceived level of ability because even if they do not complete the task successfully, they will, at least initially, maintain the same perceived level of ability by making an external attribution for failure such as *“the teacher gave me far too hard a task.”*

Dweck's (1986) research extended the concept of different motivational patterns for learning by discussing adaptive and maladaptive patterns for learning. Dweck (1986) suggested that all individuals wish to gain competence; achievement goals influence the motivation behind the wish. Children are motivated to either demonstrate competence and subsequently high ability or to improve competence and increase learning and understanding. Dweck (1986) also suggested alternative terminology to represent the two motivations; performance goals and learning goals. In line with Nicholl's (1984) review, Dweck (1986) suggested that children holding performance goals (Ego- involvement) view ability as “fixed” and children holding learning goals (task - involvement) view ability as incremental based on effort. Dweck (1986) described the outcome of a task as the main means of evaluating ability for children holding performance goals. Due to the belief of ability being “fixed”, children pursuing performance goals may exhibit signs of “helplessness” following a poor outcome as well as attributing failure to an external cause. Children may then consider other actions such as choosing an easier task in order to demonstrate ability or asking for excessive help in order to finish. For children holding learning goals an outcome of a task indicates where further effort may be applied as these children hold the belief that success stems from effort (Dweck, 1986; Nicholls, 1984). These beliefs,

together with the motivation for learning held by the child, converge to produce a pattern of distinct behaviours by influencing children's task and strategy choices. If, as Nicholls's (1984) proposes, task-involved children believe that high effort indicates high ability then more personally challenging tasks will be selected. Children who believe that success is achieved with effort are less daunted by failure and more prepared to try a range of strategies; effort can always be increased and therefore so can ability (Grant & Dweck, 2003). If children evaluate their ability based on the actions of a peer, then task choice will also be contingent on the actions of a peer. A task requiring high levels of effort may lead to a low evaluation of ability if the effort required appears to be greater than that made by their peers (Nicholls, 1984). Expending more effort will not necessarily lead to a higher evaluation of competence for a child holding an ego-involvement orientation.

2.2 AGO Labels and associated characteristics

AGO research enables us to understand how children of equal ability may differ in the way in which they interpret information, progress through a task and respond to challenge (Dweck & Leggett, 1988). Throughout the development of AGO, different labels have been used to differentiate and characterise each orientation, but appear to agree on fundamental underlying characteristics. Following a dichotomous split in motivational characteristics, achievement goals have been referred to as ego- or task-oriented goals (Nicholls, 1984), performance or learning goals (Dweck & Leggett, 1988) and performance or mastery goals (Ames & Archer, 1988; Ames, 1992). "Performance" appears to encapsulate quite succinctly the fundamental aim of this goal orientation; to display competence. Similarly, "mastery" is suggestive of the defining characteristic

of this learning orientation, that being to “master” a particular understanding or concept. Ego- and performance-oriented goals refer to similar motivational characteristics, therefore the term performance-orientation is used both within this review and the two following papers, as is mastery-orientation due to the similarity with task and learning goal descriptions (Ames & Archer, 1988; Elliott & Dweck, 2005).

Mastery orientation, compared to performance orientation, has been shown to lead to greater perseverance, especially when faced with challenge (Dweck, 1986), a greater tendency to seek out challenging tasks (Hole & Crozier, 2007), higher levels of adaptive help-seeking (Linnenbrink, 2005), deeper processing (McGregor & Elliot, 2002) and higher intrinsic motivation to work through a task towards completion (Ames, 1992; Church, Elliot, & Gable, 2001). Mastery-oriented children hold the overarching view that effort leads to success, therefore increasing effort when faced with difficulty and challenge is worthwhile. A performance-orientation engenders withdrawal in the face of challenge (Dweck, 1986), a focus on proving rather than developing competence (Dweck & Leggett, 1988; McGregor & Elliot, 2002), interpretation of some task feedback as indicative of failure, resulting in withdrawal of effort (Elliott & Dweck, 1988; Hole & Crozier, 2007) and use of surface processing and strategies such as rote learning (Ames, 1992; McGregor & Elliot, 2002).

These differences in AGO suggest that children may monitor, plan and reflect on their work in different ways; mastery-oriented children may monitor and reflect on the effort they are putting into a task and may be more prepared to switch strategies or apply further effort. Performance-oriented children on the other hand may spend more time monitoring their peers which means they may miss certain cues regarding

their own learning, such as the need to ask for further help to add understanding. The following section discusses what predictions about learners' behaviour can be made using an AGO framework, for example responses to failure, potential reasons for task choice and when children may or may not apply effort.

2.3 Useful predictions enabled by AGO framework

The different AGO motivational characteristics help predict how individuals select tasks and respond to challenge, but are not solely predictive of intellectual differences. Rather, the study strategies adopted and used throughout a task lead to children attending to different prompts. These differences then in turn lead to different task choices and outcomes, then academic gains (Elliot et al., 1999).

By measuring AGO, performance expectations, study strategies, interest and exam grades, Harackiewicz and Barron, (2000) linked mastery-oriented goals to a students' interest in and enjoyment of a task. In particular, students who had a mastery-oriented motivation reported higher levels of interest in the subject and enjoyed lectures more than student's who did not endorse mastery goals (Harackiewicz & Barron, 2000). For mastery-oriented students the process of learning appears to be the main motivator. Mastery-oriented students maintain their interest by becoming involved with the task content through trying to understand the process of what they are doing (Harackiewicz & Barron, 2000). The same study showed that performance-orientation is predictive of grades (but not enjoyment or interest) due to "positive striving" to outperform peers. Therefore performance-oriented goals can be adaptive when the context of the classroom focuses on normative assessment and outperforming peers as these children are intrinsically competitive and increase effort

to outperform their peers (Harackiewicz & Barron, 2000; Linnenbrink, 2005). However, when performance-oriented children think that their ability is low, and that this ability is unchangeable, they tend to persist less with academic tasks, as the extra effort to complete the task further confirms the evaluation of low ability. Increasing effort when an outcome is uncertain may not seem a worthwhile strategy for performance-oriented children, because of their view that ability is a fixed characteristic and that high ability means not having to expend a lot of effort to complete a task (Bell & Kozlowski, 2002). This study also indicates that for performance-oriented students, participation in a course is a means to an end (grade) and not for the sake of learning, whereas mastery-oriented students are interested in the process of learning. To cultivate an enjoyment of learning seems a worthy reason alone to fully understand the influences of AGO on task related behaviours and choices.

Children holding mastery-oriented goals tend to exhibit the same learning behaviours regardless of perceived ability. Mastery-oriented children hold the view that ability is not a fixed concept and therefore further effort can increase competence (Dweck & Leggett, 1988). Mastery-oriented children will increase effort regardless of whether they outperform peers or not. A study by Elliott & Dweck (1988) manipulated goal values and perceived ability by providing either a performance task with the information from the researcher as *"You won't learn new things but this task will really show me what kids can do"* or a learning task *"You'll learn a lot of new things, but you'll probably make a bunch of mistakes"* and by providing outcome feedback about the responses. The feedback was always given as "wrong". This was so that strategy choice could be monitored once the child knew they had made an unsuccessful move in the task (Elliott & Dweck, 1988). Children who chose the learning task worked to

increase their competence regardless of outcome feedback. Children choosing the performance task coupled with poor outcome feedback, i.e. the child was unsuccessful, focused on negative consequences and attributed their failure to a cause outside of their control making comments such as *"I'm not very good at this"* or *"you're [the researcher] switching on me"* (Elliott & Dweck, 1988). Interestingly, children working on a performance task, but coupled with feedback which indicated success on the task, showed a mastery-oriented response and persisted with hard tasks. These results indicate that the feedback in response to a task is as important as the chosen task itself. The feedback, coupled with the child's AGO, informs the child whether further effort is worth it or not. For a mastery-oriented child, further effort is worth it if learning can be increased. For a performance-oriented child, further effort is only worth it if it will confirm their ability in relation to their peers. Mastery-oriented goals are predictive of successful learning strategies and these in turn have been found to be predictive of long-term academic success (Diseth & Kobbeltvedt, 2010).

Following on from this, recent AGO research addresses the "helpless" behaviour evidenced by some children with a performance-orientation and presents a multiple goal framework proposing a trichotomous motivational split. This framework divides performance-oriented goals into two motivations; performance-approach and performance-avoidance. A performance-approach motivation orientates the learner to do better than their peers. Therefore, a child holding this orientation will pursue tasks to ensure success over peers. A performance-avoidant motivation will orient a learner to do no worse than their peers. Therefore a child holding this motivation will avoid tasks with a high chance of failure, e.g. personally challenging tasks (Elliot & Church, 1997). Both mastery-oriented goals and performance-approach motivations can lead

to positive outcomes whereas performance-avoidance goals are associated with task withdrawal and self-handicapping in order to avoid failure (Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002).

Recent addition to the AGO literature now includes a mastery-avoidance goal which indicates fear of failure through not understanding a task, or not learning enough from a particular task and although presents as a more positive goal than performance-avoidance, may also lead to disorganised studying (Elliot & McGregor, 2001).

The research suggests that the learning experience for mastery- and performance-oriented children may be qualitatively different and emphasises the importance of investigating metacognitive thinking, such as planning, strategy use and reflection as well as actual outcome such as grades. The research presented in this thesis focuses on a dichotomous AGO framework of mastery- and performance-orientation.

2.4 Application of AGO

AGO has become a useful framework for explaining and understanding task-related behaviours such as selecting challenge, help-seeking, task evaluation and perseverance. AGO determines how children respond to failure, select levels of challenge and interpret task feedback, for example as either helpful information towards completing the task or as a sign of failure, that something may be incorrect (Dweck & Leggett, 1988). These skills are often directly relevant within a classroom context making further research into AGO important for understanding why children of similar ability respond in different ways to learning and also for promoting learning

and designing learning programmes. Previous research has concentrated on understanding and conceptualising the differences within the AGO framework; the research presented in this thesis seeks to add to this understanding and investigates ways in which different AGO's can be accommodated, supported or enhanced within a classroom context.

2.5 Help-Seeking

Within both a performance- and mastery-oriented motivation, children use a range of skills in the classroom. Different learning motivations, as evidenced between AGO groups, will lead to children adopting different learning strategies. To understand fully how a child is learning within the classroom and working through tasks, it is important to understand how AGO influences strategy use and task choice. One such strategy use is help-seeking and how AGO influences how children respond to the need for help, the quantity of help children then request or seek and whether help is used successfully.

Help-seeking is considered adaptive for learning when a child recognises that help is required to complete their task and seeks just enough help to be able to continue with the task independently (Roussel, Elliot, & Feltman, 2011). Seeking "just enough" help will enable the child to gain mastery of the task and is referred to as instrumental help-seeking. When a child's goal is to be the first to finish a task, use little effort or avoid challenge, then excessive help-seeking may be requested or sought. Excessive help-seeking may be requests for the full answer so that the task can be completed with little further effort and is referred to as executive help-seeking (Nelson-Le Gall & Glor-Scheib, 1985). Being able to seek appropriate help is essential when progressing through unfamiliar tasks, whether this means finding out further

information for oneself, thinking back over previous learning, using a resource or asking another person for assistance. Children may have different aims when selecting help; they may wish to have a hint, confirm they are right so far, finish the task quickly or avoid challenge and these aims, or goals, will influence how, when and what type of help is requested (Nelson - Le Gall & Glor-Scheib, 1985). These different aims may be influenced by AGO. Performance-oriented children motivated to display and prove competence in relation to peers may seek excessive help in order to finish quickly without displaying too much effort. A mastery-oriented child motivated to increase their competence through understanding may seek small amounts of help or a prompt in order to work out the answers themselves.

In a classroom environment, when the expenditure of effort and the evaluation of competence are judged so differently between AGO groups, it is unsurprising that children of different AGOs might also think differently about help-seeking. Roussel, Elliot & Feltman (2011) investigated the links between mastery-oriented and performance-oriented approach and avoidance goals, instrumental help-seeking and attitudes towards help-seeking. By taking individual measures of students' AGO and attitudes towards help-seeking Roussel, Elliot & Feltman (2011) found that children endorsing mastery-oriented goals perceived help-seeking as useful; for example viewing help-seeking as a useful strategy to enhance learning. In contrast, children endorsing performance-oriented goals perceived help-seeking as a "cost"; for example *"I think school mates might think I'm dumb when I ask them a question"*. Children with this orientation apparently see the need for help as indicating low ability (Roussel, Elliot, & Feltman, 2011).

Students develop beliefs about the perceived costs and benefits of help-seeking and select support contingent on these beliefs and it is possible to see how these beliefs may be influenced by AGO. For example, if a child is motivated by mastery-oriented goals to improve their learning about a particular subject, they will request help specifically to improve their learning. The benefits of improved learning outweigh the possible costs of requesting help because the salient motivation is improvement in learning. If a performance-oriented child believes that finishing a task ahead of a peer yields the most benefit then asking for help will be a worthwhile cost. For example, a performance-oriented child who is motivated to achieve better than, or no worse than, their peers may view seeking help as a quick means to this end; finishing the task first may balance the perceived cost of needing assistance. A performance orientation leads to evaluating help-seeking in terms of whether it will provide a positive peer evaluation (finishing ahead of a peer) or negative peer evaluation (indicative of low ability) (Ryan, Pintrich, & Midgley, 2001). Therefore, for performance-oriented students, asking for help also needs to be balanced with the belief that requesting help will make them look less competent. This calculus could lead to children avoiding asking for help, or choosing tasks that can be more easily completed. It is not necessarily that performance-oriented children do not recognise when they need help, rather that they actively avoid asking for help if the perceived costs, such as poor peer evaluation, outweigh the perceived benefits (Roussel et al., 2011). This avoidance may mean that children ignore certain questions, choose easier tasks or actively disregard help embedded within a task or an environment. This is an aspect of help-seeking explored within the first paper presented in this thesis.

Mastery-oriented children, who are seeking to extend and consolidate their learning, are found to seek help because they aim to understand a task and gain competence and therefore seek information to help them finish the task independently, such as a clue or hint (Newman, 2002; Roussel et al., 2011). Mastery-oriented students view competence as understanding more than they did before and tend to request hints and confirmation of work already completed in order to monitor and plan their progress. Mastery-oriented children may also consider peers as a helpful resource (Darnon, Butera, & Harackiewicz, 2007). In comparison, students holding performance-oriented goals view competence as being ahead of, or at least not behind, peers. Performance-oriented children may have conflicting thoughts: asking for help suggests they have low ability, but not asking for help could lead to failure. If a performance-oriented child perceives their ability as high then the perceived cost of asking for help will not be so high, but if a performance-oriented child doubts their ability, then needing help will further compound this belief (Bereby-Meyer & Kaplan, 2005). In the latter example, a student may resort to task avoidance, for example by choosing a lesser challenge or “covert” help-seeking such as discreet copying of a peer’s answers (Butler, 1998). Following a child’s task actions from start to finish gives a much clearer picture than relying on an outcome measure such as a grade. Analysing a final outcome without an understanding of the task progression and choices may mask different motivations and behaviours.

Studying help-seeking from an AGO perspective can aid predictions about classroom behaviours. Children with different orientations may display similar behaviours, but with different underlying motivations. For example, a mastery-oriented child may select an easier task in order to gradually progress and build upon

their knowledge whereas a performance-oriented child may select an easier task in order to avoid failure, avoid having to ask for help or simply finish quickly in order to beat a peer. Children of either AGO may fulfil the same academic standard but the learning process of each may be qualitatively different. Sustained interest in a task, as evidenced with mastery-oriented children, may lead to an underlying understanding whereas avoiding certain tasks or requesting excessive help, as evidenced with performance-oriented children, may lead to less confidence and reduced interest in further tasks (Pintrich, 2000).

To fully assess, compare and comment upon help-seeking behaviour, it is important for a researcher to understand the motivation behind each learning choice. To do this successfully requires viewing the whole task behaviour starting with choosing a task, the process and strategies employed throughout and then the outcome achieved, rather than using grades and outcome as a measure of difference. Paper 1 seeks to investigate differences in help-seeking strategies by comparing the progress of a task from selection to completion by children with different AGOs. The second study then presented in Paper 1 investigates how offering metacognitive support within a learning program may aid and support children's task choices and progress.

2.6 AGO within the context of the classroom

The goals adopted by or salient to an individual determine task behaviour within a learning situation and can help predict the amount of effort and persistence directed at the task, as well as the motivation behind challenge-seeking or avoidance and reaction to failure or success (Elliot, McGregor & Gable, 1999). Recognising AGO in the context of the classroom can promote understanding of individual learners and

help predict areas of difficulty or ease. Paper 2 seeks to evaluate the influence of a mastery-oriented approach on metacognitive reflection and cognitions relating to learning such as sense of efficacy and liking of a subject. The research presented in paper 2 is focused on a whole class approach rather than dispositional AGO.

The research discussed in previous sections has investigated both situational AGO (e.g. Ames, 1984) and dispositional motivation and attitudes (e.g. Roussel, et al, 2011) and suggest that both individual characteristics and situational demands influence the behaviour of a learner. As discussed previously, the nature of tasks assigned as either a test or a learning task and student grouping as either individual or competitive can influence how salient particular achievement goals are for children. Classroom context and achievement focus as presented by the teacher may also influence the adoption of personal achievement goals and achievement behaviour (Meece, Anderman, & Anderman, 2006). Ames and Archer (1988) found that when students perceived the classroom structure as being more mastery-oriented, for example strongly agreeing with statements such as *"The teacher makes sure I understand the work"*, then students reported using more learning strategies and selecting tasks presenting more challenge. For example, students perceiving the class as being more mastery-oriented tended to rate statements such as *"I try to pull the information from class and readings"* as being "typical of me". Students' answers when perceiving a performance-oriented classroom structure, for example, strongly agreeing with statements such as *"Only a few students can get top marks"* were unrelated to learning strategies or task choices. Performance-oriented students tended to focus on their perceived ability and attribute failure to lack of ability and the difficulty of the work. In contrast, if the emphasis within the classroom is on effort

and task mastery, rather than extrinsic gains and peer comparison, the influence of perceived ability on choice of task, learning strategy and persistence is reduced (Ames & Archer, 1988).

A mastery-oriented focus in a classroom may encourage children to select tasks to increase their competence and understanding and will place less emphasis on being better than, (or no worse than) a peer). A mastery-oriented classroom may place value on effort and improvement rather than normative assessment and will therefore encourage challenge-seeking. Alternatively, a focus on evaluation will increase the salience of performance goals within the classroom context and may influence students to select tasks with a guaranteed successful outcome, rather than tasks which may be personally challenging but would also enhance learning and understanding (Ames & Archer, 1988; Church et al., 2001). For example students in such a situation might choose tasks which they have completed successfully on previous occasions rather than choosing new or more challenging tasks requiring further effort and study.

Harris, Yuill & Luckin (2008) suggest that promoting a particular AGO within a classroom may be more influential amongst primary age children than individual AGO. Children receiving performance-oriented instructions, for example emphasising the maximum number of points or score possible, tended to concentrate more on the task outcome, rather than spend time discussing good solutions and strategies (Harris, Yuill, & Luckin, 2008). This performance-oriented focus affected the strategies employed throughout the task, including help-seeking, leading to more requests for the answer and less time trying to work and apply suitable strategies such as *“considering and discussing hints”*. Children receiving mastery-oriented instructions requested less external help and instead appeared to use their partner as a useful resource and

engaged in greater problem-solving discussions (Harris et al., 2008). Promoting a mastery-oriented context appears to have encouraged children to view peers as a useful resource rather than competition. Discussing possible outcomes and answers may lead to deeper processing and more retention of material and therefore greater learning and understanding. From these studies, it can be seen that children holding performance-oriented goals may be less likely to consider peers a useful resource if they perceive that they are in competition with their peers. Using peers as a resource may threaten a child's perception of their own ability as the child acknowledges that they need help and that a peer may know something that they themselves do not.

The studies presented in this research seek to add to the understanding of AGO within a classroom. The two papers research the influence of AGO in two different ways; paper one uses software supporting learning about ecology and children's individual AGO, whilst paper two investigates a whole-classroom approach embedding mathematics within a creative project.

3. 0 Paper 1

Seek, ignore or avoid: How achievement goal orientation influences children's help-seeking during an interactive science task.

Abstract. Research into achievement goal orientation (AGO) has established that different motivations for learning can lead to different task behaviours. Mastery goals are associated with a desire to improve competence and adaptive help-seeking skills, whereas performance goals are typically driven by proving ability and either a reluctance to seek help or requesting the full answer rather than a hint. AGO research therefore presents a useful framework within which to understand how children seek information and select and use help to complete classroom tasks. This study extends previous research into AGO and children's help-seeking by investigating information gathering, help-seeking and post-help behaviour throughout a classroom-based task.

Sixty-four primary school children (mean age 9yrs, 6 mths) took part in the studies using science based educational software. We hypothesise that children differ in their help-seeking behaviour according to their AGO and that metacognitive support will help reduce these differences.

Results indicate that performance-oriented children select higher levels of help than mastery-oriented children. Performance-oriented children appear more reluctant to choose challenging tasks if a successful outcome is uncertain. Our second study reduces these differences and post-test results are consistent with the idea that carefully providing feedback and embedding metacognitive support is useful in reducing differences between AGO groups.

Key words: Achievement Goal Orientation, Help-seeking, and Metacognition.

3.1 Introduction

Help-seeking is an essential and adaptive classroom skill and successful use depends on several factors such as metacognitive awareness and achievement goal orientation (AGO). Metacognitive awareness helps children organise their learning strategies, plan and monitor progress which can lead to an understanding of when help is required (Ryan & Pintrich, 1997; Ford, Smith, Weissbein & Gully, 1998). Children of the same academic ability may have different motivations for completing a task and may respond differently in the way they seek help (Ryan, Patrick & Shim, 2005). Understanding these differences is important in order to provide support for effective help-seeking and independent learning to encourage reflection, understanding and perseverance (Dweck & Leggett, 1988).

Using an AGO framework, the research presented in this paper focuses on help-seeking behaviour throughout a task. By looking at learner's task choices, we seek to establish the influence of AGO classroom-based behaviours.

3.2 Achievement goal orientation

Achievement Goal Orientation (AGO) historically includes two broad motivational categories, mastery and performance. Mastery-oriented children tend to evaluate their work based on their own previous attainment and are motivated to learn, increase their understanding and improve upon their personal best, whereas performance-oriented children typically compare their work with that of others and are motivated by gaining favourable comparison to others (Elliott & Dweck, 1988). A mastery-oriented motivation may lead to working for longer on a particular task, choosing harder activities and seeking help that allows them to work out an answer (Pintrich, 2003). Performance-oriented children on the other hand are trying to be

better than their peers, or at least no worse. This motivation may lead to choosing less challenging activities so as to achieve them more easily or seeking help which provides a quick answer to complete a task (Hole & Crozier, 2007).

A performance-orientation can be effective in some circumstances, trying to score highest in an exam for example, but problems may arise in situations that present an unexpected level of difficulty or unanticipated failure (Pintrich, 2003). A mastery-orientation prioritises understanding, which has traditionally been seen as the main goal of education. In this case a mastery orientation can act as a buffer to promote resilience and encourage perseverance regardless of a child's perceived ability; the concern is with improving one's own learning rather than evaluating ability against that of another child (Dweck & Leggett, 1988; Pintrich, 2003). Performance-orientation can be further split by approach and avoidant motivations characterised by seeking to do better than a peer or avoiding doing worse than a peer. This paper concentrates on a dichotomous split of either mastery- or performance-orientation.

Previous research has demonstrated the difficulty of accurately measuring the AGO of children due to a social desirability bias (Harris, 2006; Bonnett, 2007). Children may be influenced during interviews by implied beliefs of the adult researcher, possibly inferring that a particular response is required rather than relying on their own opinion (Lamb & Brown, 2006). Providing scenarios for a child that elicit an elaborated response allows spontaneous discussion of motivations. Providing a storyboard of realistic classroom scenarios makes it easier for children to think about relevant behaviour rather than asking about abstract circumstances (Brown, 1988). One aim of this study is to engage children in open-ended discussions about their motivations. This study uses a novel interview method designed to elicit an accurate

measure of a dichotomous AGO profile (Harris, Bonnett, Luckin, Yuill & Avramides, 2009).

3.3 Metacognition and Help-Seeking

Effective help-seeking starts with recognition of when help is needed. This is an important metacognitive skill, integral to planning and monitoring a task (Ford et al, 1998). Ideally, areas of difficulty are recognised by the learner so that the right amount of help is requested and then used where it is most necessary. However, children do not always recognise when they need help, they may avoid asking for help or they may seek excessive help. If children are not seeking effective help, then their learning as well as their ability to generalise to future tasks will be compromised. Previous research suggests that learners sometimes make ineffective use of available help either by over-selecting clues or ignoring help prompts (Aleven, McLaren, Roll, Koedinger, 2007). It is important to gain an understanding of the motivation behind help choices and information gathering both in the expanding world of on-line tutoring, as well as more traditional classroom based tasks. One way of exploring how children are managing their learning is to use the AGO framework and investigate differences in help-seeking between mastery- and performance-oriented children.

Nelson-Le Gall and Glor-Schieb (1985) distinguish two types of help, executive help and instrumental help. Executive help-seeking is aimed at completing a task rather than learning and the focus is on a quick solution (Roll, Aleven, McLaren, Koedinger, 2011). This help-seeking depends on another resource being available, such as an answer book or an expert, but does not encourage wider learning or perseverance. Seeking executive help where there is a set goal may be expedient if it leads to a quick resolution: however continued reliance on others does not aid the

overall process of problem-solving and will not benefit children in a move towards independent studying (Nelson-Le Gall & Glor-Scheib, 1985). Seeking instrumental help, a non-specific hint for example, is low-level help-seeking and the majority of the thinking is left to the child. Asking for the minimal level of help enables children to complete the task on their own and gain an understanding of the underlying principles, which can then be generalised to other tasks (Nelson-Le Gall et al, 1985; Butler, 1998, Harris et al, 2008; Roll et al, 2011).

AGO guides behaviours that children adopt in order to reach their goal, either of mastering a task or performing favourably when compared with a peer. Therefore, AGO will also influence student attitudes to help-seeking as being either a benefit to enhance learning, getting the task finished, or else detrimentally serving to make the learner look less than able (Roussel et al., 2011). Newman (1998) suggested that mastery-oriented goals have a “positive influence” on help-seeking skills, such as requesting a hint or simply confirmation that the student is on the right track, whereas performance-oriented goals have a “negative influence” manifesting as requesting excessive help, or avoiding help even though needed. Newman (1998) also found that children with performance goals working in a performance-oriented environment are less likely to seek help. This paper seeks to investigate these behaviours using an AGO framework and thus gain an insight into task-related behaviour. The research is conducted using a computer-based science task within a typical classroom setting. We predict that performance-oriented children will ask for excessive help to aid a quick completion of the task or they may choose less challenging tasks so as to avoid needing help (Butler, 1998; Nelson-Le Gall & Glor-Scheib, 1985).

Seeking appropriate help is not the only variable active in task completion. To fully assess differences in mastery- and performance-orientation classroom behaviours, we need to know how children are going to use their help and what other information they seek to help complete tasks. Using a computer program which creates an online record (log) of children's task choices is one of the strengths of this study and enables us to see which type of help has been selected as well as actions following selection.

3.4 Ecolab II

Ecolab II is educational software that children can use as part of the 7 – 11 year olds (UK Key Stage 2) ecology curriculum to help understand food chains and food webs (Luckin & Hammerton, 2002). The software addresses some metacognitive difficulties by offering children help through a degree of intelligence inherent in the program. The software tailors help prompts by offering more or less help in line with how the child is progressing (Luckin et al, 2002; Harris, et al, 2009). Supporting help-seeking in this way aims to encourage exploration and learning. Building an online model of each learner creates a rich profile of each child's task behaviour.

Ecolab II presents a virtual world for a variety of organisms, both plants and animals. The program offers three different screen views for the children to explore; the world view, which shows each organism in its natural habitat, the energy view which indicates differing energy levels between organisms and the web view, which depicts the organisms in their food chain order. Children can gather extra information about the task by swapping between the screen views (Figure.3.1)

The children were asked to make a food chain, linking two or three organisms together. The program provides choices, and children can choose to make a two-link

food chain or choose a harder option of linking three organisms, e.g. “toad eats slug and is eaten by grass snake”. Children have the option to select a different action if they cannot complete the choice they selected.

The program offers the learner three ways to seek help. First, being able to choose different screen views allows children to seek extra information. For example, the web view will show the children where their selected organism fits in the food chain hierarchy. The energy view is the least useful screen for the task of linking organisms as it does not offer extra information pertinent to food chains. Second, children can learn about the organisms’ food chain hierarchy by selecting the organism itself, e.g. clicking on a caterpillar will give the information “I am a caterpillar and I eat rose leaves”. Finally, if the child makes a mistake, a clue choice is presented automatically on the screen using dice symbols, numbered 1 to 4. Clues 1 and 2 offer the least amount of information, for example, “That’s not quite right. Have another go; I’m sure you can do it”. This is aimed at encouraging children to keep going and keep seeking information and is therefore classed as low-level instrumental help. Clues 3 and 4 use organisms in an example; “Let’s try an organism that eats and is eaten, like Stickleback. Stickleback eats tadpole and is eaten by Heron”. These two clues provide specific task information linked to the actual answer required by the child and is therefore classed as high-level executive help. Clues 3 and 4 always offer the same generic example. The children can choose any one of the four clues.

Second, Ecolab's logging system allowed us to reliably investigate learner behaviour. The software logged clue choice and how the children used each clue. The software also logged movement between screen views allowing us to gather information on how children seek relevant information to help task completion. This built a rich picture of help-seeking behaviour throughout the task.

We hypothesised that children would differ in their help-seeking behaviour as a function of their achievement goal orientation; performance-oriented children would select high-level executive help and show less challenge-seeking by either selecting easier two-link actions or swapping from a harder to an easier food chain after an error than mastery-oriented children.

3.5.1 Method

Participants

Participants were 27 children (16 boys and 11 girls mean age 9:8) attending a semi-rural primary school in East Sussex. A further 8 were tested, but excluded from analysis as they were unable to be reliably assigned to an AGO. Parental consent was obtained prior to the study (appendix 8.1.1) and the head teacher also signed consent (appendix 8.1.2). Each child participated in two sessions about a week apart. The first session was an individual interview session to assess AGO. For the purposes of a separate study interested in combined effort we included pairs working together. During this study these pairs (combined effort) were analysed as one unit (two children equalling one score) meaning that there were 9 units of mastery-orientation and 10 units of performance-orientation in total. Pairs acting as combined effort were matched for AGO and gender. The second session was a 30-minute interactive science task, using Ecolab II, in which children worked either individually $n = 11$ or pair, n

(combined effort) = 8. Each child was allowed a few minutes to become familiar with the software and was then required to make two food chains with a common denominator. Pilot work showed that the task was of a suitably high level to ensure that most children would require some assistance.

3.5.2 Measures

Achievement Goal Orientation

Each child's AGO profile was assessed. Two classroom scenarios depicting a mastery- and a performance-oriented child (see figure.3.2) were presented to children individually on laptops. Boys were presented with male characters and girls with female characters.

Figure 3.2 Mastery- and Performance- oriented storyboard characters



Mastery-oriented Child



Performance-oriented child

Children were asked to predict how each character might respond to a given task, e.g. "What would Sophie do if she found this task hard?" to think about their own behaviour, e.g. "what would you do if you found this task hard" and then select which of the two characters was most like themselves (appendix 8.1.3). The children showed a good understanding of the mastery and performance behaviours of the two characters and provided a range of answers and strategies regarding their own behaviour, which added further AGO information to the profiling. Two raters scored

the session holistically looking for characteristics typical to each orientation as defined in the literature (Table 3.1) (Dweck & Leggett, 1988; Ford et al, 1998; Church, Elliott & Gable, 2001; Pintrich, 2003). The children's responses to the scenarios were used to assign an AGO for each child as these were considered indicative of the child's motivation for classroom learning.

Orientation	Achievement Motivation	Possible Strategies	Task Choice
Mastery	"I don't think they should ever give the answer [to a question] because it doesn't help learning at all"	"If I got stuck I would write everything down I do know and then get a book to find out some more."	[I would choose task 2] "There is more to it, it looks a bit harder, I like giving myself a challenge"
	"Even if I'm wrong I can still learn something"	"I dig deep to see if I can remember and then maybe ask the teacher to read it out again which can help."	"I'm going to go for the one that I think I need to work on so I'm going to go for that one."
Performance	"I like to show I know the answer, if one comes up that I definitely know I put my hand up"	"I never put my hand up in case I look silly"	"I would choose [task 1] because [task 2] is a bit too complicated for me really"
	"I would feel scared if it was a test because I might get lower than other people"	[I would ask for help]"To help me to get the answer faster than I would on my own"	Task 1 "I would choose [task 1] It's a bit easier, I can tell already"

Table 3.1: An example of different AGO responses

Due to the novelty of this method, two raters scored the interviews and resolved any disagreements through discussion. Of the 27 children 13 were classified as mastery oriented (7 boys and 6 girls) and 14 (9 boys and 3 girls) as performance-oriented. These children were then randomly allocated to either a combined effort or individual allocation for interaction with the software (see Table 3.2).

Table 3.2: Allocation of mastery- and performance-oriented children

	Working as combined effort		Work as Individuals	
	Boys	Girls	Boys	Girls
Mastery	4 (2 pairs)	4 (2 pairs)	3	2
Performance	6 (3 pairs)	2 (1 pair)	3	3

3.5.3 Procedure

Children were told about the different screen views and the task always started with the world view. Children were not told that information could be gained by clicking on each organism, so we could compare how children explored the software. Children were told that they could select help from the software. The hierarchy of the clues was explained to each child with Clue 1 containing the least amount of information “just a little hint” and Clue 4 being the most helpful “almost the full answer”. Children were asked to build two food chains with one organism in common, a “common denominator”.

3.5.4 Software Learner Models (log)

The system log files recorded all the interactions with the software, screen views, total number and type of food chains attempted, clue totals, and how clues were used, successfully or not.

3.5.5 Results

As session lengths varied slightly all data was transformed into percentages. Means and standard deviations of all study variables are shown in Table 4. The homogeneity of variance assumption was violated for two of our variables, percentage of two-link food chains that are correct and percentage of three- link food chains that are correct, so the Welch value is reported for significant results. Although no specific hypotheses regarding gender or combined effort have been made, any significant effects are reported.

3.5.6 Food chains

Mastery- and performance-oriented children attempted the same overall number of food chains (table 3.4.) A 2 (AGO) x 2 (within factor type of food chain) analysis of variance indicated significant differences in the type of food chains attempted, with performance-oriented children attempting more two-link food chains than mastery-oriented children, $F(1,17) = 5.36$, $p < .05$, $r = .5$ (fig. 3.3). Mastery-oriented children consequently attempted more three-link food chains than performance-oriented children.

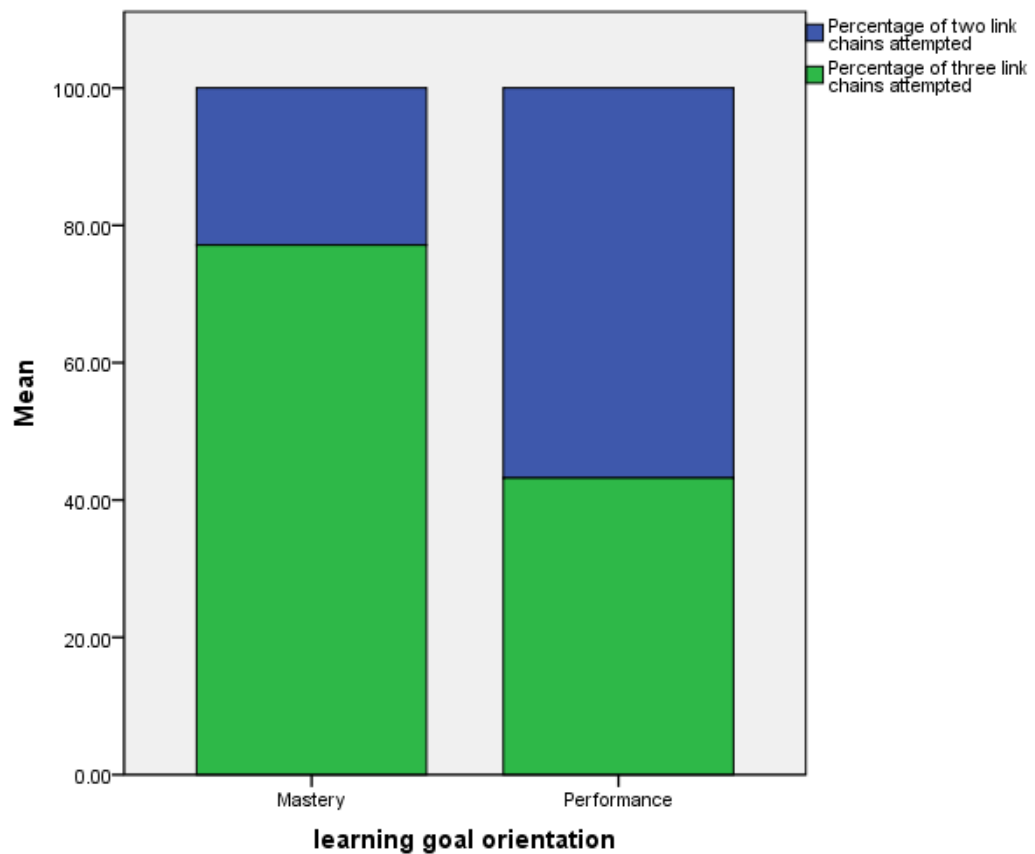


Figure 3.3: Percentage of two or three link food chains attempted

There were no significant differences in the number of two-link food chains correctly completed. Mastery-oriented children achieved significantly more correct three-link food chains than performance-oriented children, $F(1, 12.03) = 11.34$, $p < .01$, $r = .6$. There was also a main effect of combined effort or individual interaction on the percentage of two-link food chains correct, children with combined effort achieving significantly more correct two-link food chains than individual children, $F(1, 17) = 6.74$, $p < .05$. To further examine this effect, within group differences were analysed and combined effort mastery-oriented children were compared with individual interaction mastery-oriented children. Mastery-oriented children with combined effort achieve significantly more correct two-link food chains than mastery-oriented children in the individual allocation, $F(1, 7) = 9.33$, $p < .05$, $r = .7$. (Table 3.3). There were no significant differences within the performance-oriented children group with both individual

interaction and combined effort having similar scores (Table 3.3). It should be noted however, that these are comparisons of small numbers of children and should be interpreted with caution.

Table 3.3: Completed two-link food chains by individual or combined effort AGO

	Individual	Combined effort
Mastery-oriented	20.00 (44.72) (n = 5 individuals) *	90.75 (10.75) (n = 4 pairs)
Performance-oriented	42.00 (24.27) (n = 6 individuals)	54.75 (37.43) (n= 4 pairs)

* $p < .05$ significant difference within mastery-oriented condition

3.5.7 Clues

If children made an incorrect choice for their food chain they were automatically presented with the opportunity to choose a clue. Table 4 shows the mean number of times each level of clue was selected. When looking at total number of food chains, there were no overall significant differences between AGO groups in the level of clue they selected. When looking at two-link food chains, performance-oriented children were significantly more likely than mastery-oriented to select a high-level clue when making an error, $F(1,17) = 8.48$, $p < .01$, $r = .5$. (Figure 3.4)

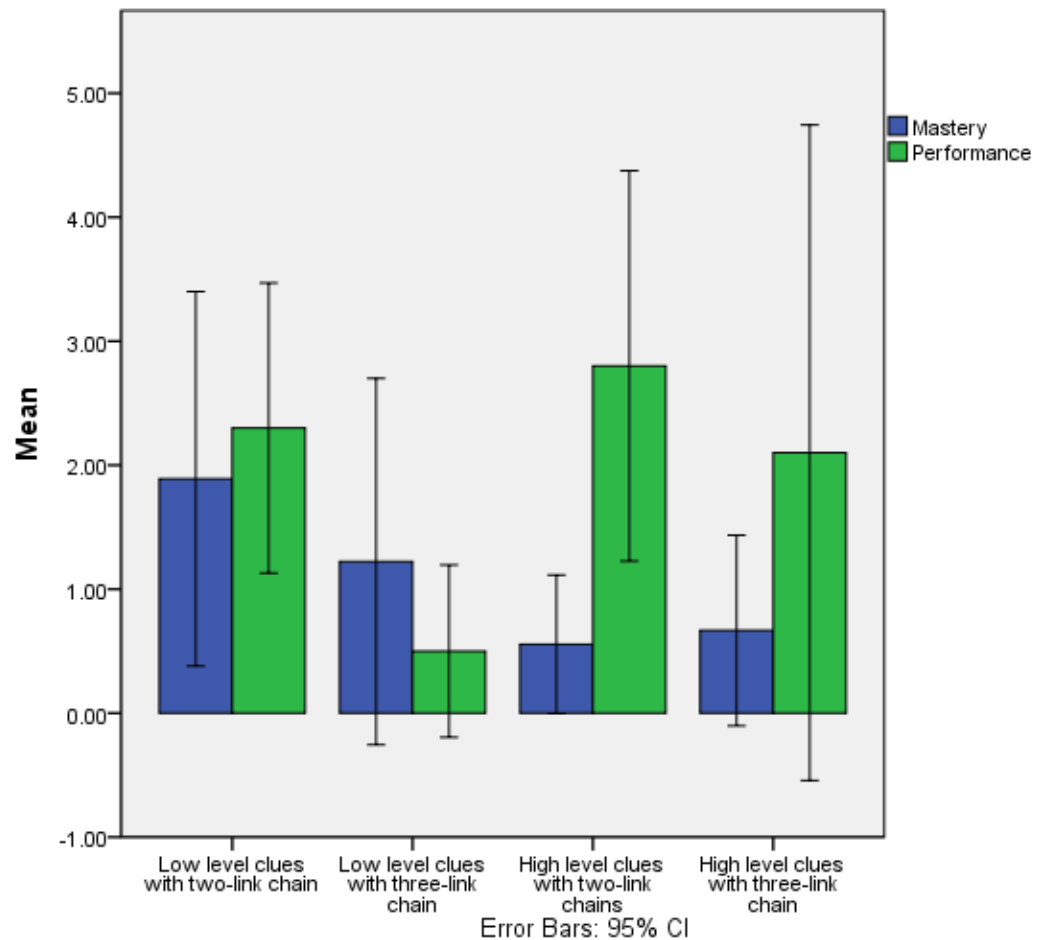


Figure 3.4: Level of clue associated with type of food chain attempted

There were no significant combined effort / individual interaction effects on the level of clue associated with either food chain. There was a gender effect on level of clue selected: boys chose significantly more low-level help than girls, $F(1, 17) = 5.18$, $p < .05$. This could be accounted for by more performance-oriented boys ($n=9$) than girls ($n=5$). There were no significant differences by AGO group in actions following a clue and there were no significant differences overall in number of clues received.

Table 3.4: Means (standard deviations) of children's behaviour whilst using software

	Mastery (n = 9)		Performance (n = 10)
<u>Food Chains</u>			
Total no. food chains Attempted	9.89 (4.57)		11.5 (5.83)
Percentage of correct Food chains	78.33 (12.69)	**	56.90 (17.82)
Percentage of incorrect Food chains	21.67 (12.69)	**	43.10 (17.82)
<u>Clues</u>			
Clue Total	4.33 (3.46)		8.10 (5.11)
Percentage of Low-level Clues	57.14 (42.32)		45.04 (31.65)
Percentage of High-level Clues	42.86 (42.32)		54.96 (31.65)
<u>Two link food chains</u>			
Percentage of two-link Food chains attempted	22.89(22.50)	*	56.80 (38.35)
Percentage of two-link Correct	51.44 (49.33)		47.1 (28.94)
Percentage of two-link Incorrect	15.22(32.79)		32.90 (22.85)
Two-link low-level clue	1.89 (1.96)		2.3 (1.63)
Two-link high-level clue	.55 (.73)	*	2.8 (2.2)

Table 3.4 cont.

Three link food chains

Percentage of three-link Food chains attempted	77.11(22.50)	*	43.20 (38.50)
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Percentage of three-link Correct	76.67 (14.96)	**	33.30 (37.55)
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Percentage of three-link Incorrect	23.33 (14.96)		46.70 (41.33)
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Three-link low-level clue	1.22 (1.92)		.50 (.97)
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Three-link high-level clue	.67 (1.0)		2.1 (3.7)
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Post Clue Behaviour

Total % Clues Followed by Correct food chain	60.58 (36.32)		37.16 (24.98)
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Total % Clues Followed by Wrong food chain	21.62 (28.04)		25.14 (18.44)
---	---------------	--	---------------

Total % Clues Followed by choosing Different Organisms or action	16.21 (15.33)		35.19 (23.98)
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Views

Total No. of changes To Web View	6.78 (1.71)	*	4.8 (1.32)
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Total No. of changes To Energy View	1.44 (.88)		3.4 (2.84)
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Total No. of clicks On organisms	24.67 (15.33)		15.2 (9.66)
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* p < .05 significant differences between mastery and performance children

**p < .01 significant differences between mastery and performance children

3.5.8 Post Clue Behaviour

After choosing a clue, children could continue with their chosen food chain, select another clue, seek further information from the program such as changing web view or clicking on a specific organism, or children could choose to swap actions to a different food chain or different organisms. Table 3.5 shows that performance-oriented children were significantly more likely than mastery-oriented children to give up following a high-level clue, $F(1, 13) = 5.23$, $p < .05$, $r = .5$.

Table 3.5: Means (standard deviations) of clue outcome following a low- or high – level clue

	Mastery		Performance
	(n = 9)		(n = 10)
% of low-level clues followed by giving Up (choosing different Organisms or action)	45.83 (41.66)		58.33 (45.82)
% of high-level clues followed by giving Up (choosing different Organisms or action)	5.00 (10.00)	*	24.30 (24.50)

* $p < .05$ significant interaction with condition

3.5.9 Screen Views

Mastery-oriented children used the web view significantly more than performance-oriented children $F(1,17) = 8.04$, $p < .05$, $r = .5$. Performance-oriented children used the energy view more often than mastery-oriented children. This difference approached significance $F(1,17) = 3.92$, $p = .06$, $r = .4$ (Table 3.4).

3.6.0 Discussion

The results support our first hypothesis that there would be differences between mastery- and performance-oriented help-seeking behaviour. Mastery-oriented children appeared to seek task-related information from the software, such as the web view, in addition to clues to complete their food chains more often than performance-oriented children. This suggests that these children were motivated to gather information from the program as well as use help to support their task.

Mastery- and performance-oriented children attempted a similar number of food chains, but for mastery-oriented children a significantly greater proportion of these were the more complicated three-link action “Eats and is Eaten by”. Mastery-oriented children also successfully completed a greater number of food chains. The small within-group comparison of mastery-oriented children suggests that these children used each other as a resource to progress through the task as well as help information available within the task: this result was not evident within performance-oriented pairs’ actions.

Performance-oriented children appeared less efficient than mastery-oriented children in their help-seeking behaviour in three further ways. First, their information-seeking did not always help complete their selected action. Performance-oriented children did not use the web view as often as mastery-oriented children during their

exploration, suggesting they were not seeking useful information for task completion. Second, performance-oriented children selected high-level clues significantly more often than mastery-oriented children for the easier two-link food chains. These clues did not lead the performance-oriented children to a successful completion of food chains, suggesting that their usefulness was limited. Performance-oriented children did not try as many three-link food chains as the mastery-oriented children. This suggests that performance-oriented children were less able to generalise their learning from the easier two-link food chain to the more complicated task and less inclined to seek challenge. Finally performance-oriented children gave up more often on the food chain for which they had chosen a clue, choosing either different organisms or a different action. This meant that rather than using the help and trying the same link again, performance-oriented children tried switching from “eats and be eaten” which links three organisms, to an action of “eats” which only links two. This suggests that having made a mistake, highlighted by the receipt of a clue, these children preferred to try something easier to reach a correct solution rather than using the information to try again when the outcome was in question. In theory, this could have been a good strategy to get the easier task finished and understood before moving onto the harder task, but in reality this is not what happened. Achieving fewer correct food chains than mastery-oriented children may be a result of switching tasks rather than persevering or going straight for a high-level clue and therefore not learning transferable information.

The high-level clues giving the most help gave the correct format for a generic food chain solution, “Stickleback eats tadpole and is eaten by heron”, rather than the specific organisms the children were working with, e.g. toad, slug and lichen.

Performance-oriented children appeared less able to use the generic clue structure to help them solve the food chain they were working on. The system logs show that performance-oriented children either switched to the organisms presented in the clue and therefore consistently repeated the same food chain, or else shifted to another action entirely. They appeared to either treat this clue as the specific answer irrespective of what they had been working on or were unable to use it as an illustrative example to good effect. Mastery-oriented children appeared better able to generalise from these clues to use the clue as an example of the correct sequence for their food chain, and complete the specific food chain they had started. A common error during this task was to select the right organisms for a food chain, but not sequence them correctly. Mastery-oriented children appeared able to use the generic clue to help with the sequencing, whereas performance-oriented children were not, choosing instead to swap action or organism entirely. It is also possible that performance-oriented children viewed receiving a clue as negative feedback as the clues appeared automatically after an incorrect choice. If the clue did not lead to a correct answer, children may have been concerned about repeating an error and so switched task so as to avoid certain failure. This supports previous research detailing possible negative influence of performance- oriented goals on help-seeking behaviour (Butler, 1998; Newman, 1998). Using a classroom task extends this research by examining learner's actual behaviour in detail through each instance of help and challenge.

Although Ecolab II offers the children automatically-generated clues, performance-oriented children attended less well to them than mastery-oriented children did, preferring instead to switch actions. It is possible and consistent with the

literature, that performance-oriented children were ignoring or avoiding selecting clues or were less aware that they needed them. The researcher observed that some children tried to exit the help box without selecting a clue. Performance-oriented children may have felt that they wanted to progress on their own and try again without help or that receiving help would in some way lessen their result (Butler, 1998).

There are several questions remaining after this study. Although the results show behavioural differences, the absence of an outcome measure meant that the effects on either mastery- or performance-oriented children are unclear. It is possible that performance-oriented children were of a lower academic ability than mastery-oriented children and it is not possible to clarify this without a pre-test measure. It is also possible that switching food chains or organisms after a mistake is a learning strategy employed by performance-oriented children allowing them to feel like they are progressing rather than making errors, thus maintaining overall task motivation. Adding a pre- and post-test would allow for comparisons of learning gains between AGO groups of children. Performance-oriented children tended to be more likely than mastery-oriented children to give up after receiving a high-level clue. This may have been due to problems generalising from the generic clue example. Adding a problem pre- and post-test which required generalisation would enable us to assess each child's ability to generalise, both before and after the computer task.

3.7 Study 2

This study seeks to address the questions raised by Study 1 and we made some modifications to the software to address potential problems indicated in Study 1. Four changes were made to the study. First, a pre- and post-test was added so as to provide

a base measure of domain understanding and to measure the impact of help-seeking on learning outcome. Second, the possible problem of generalisation was addressed by changing the high-level clue format to link the children's organism choice specifically to the example given in the clue. This meant that children received information directly linked to the organisms they had selected, rather than a generic example always using the same organisms. Third, the metacognitive support messages were adapted to make help more salient and harder to simply ignore, with audio added to the visual on-screen prompts. This aimed to draw children's attention to the clue level recommended by Ecolab II, to encourage more flexibility in clue selection. Finally, children were each given an Ecolab II workbook with suggested activities to encourage exploration of the software. All interaction with the software was as individual participants rather than combined effort.

By making these adjustments, we sought to extend findings of Study 1. We hypothesised that the increased level of metacognitive support in Ecolab II would be useful for performance-oriented children in regulation of help-seeking behaviour and successful use of clues. We hypothesised that offering more specific help should reduce differences between mastery- and performance-oriented children's use of help resulting in equal numbers of successfully completed food chains.

3.7.1 Method

Participants

Participants were 29 children (13 boys and 16 girls mean age 10:2) attending a semi-rural primary school in East Sussex.

3.7.2 Measures

The AGO assessment was administered as in Study 1. All children could be classified (see Table 3.6).

Table 3.6: Mastery- and Performance Orientation classification by gender

	Boys	Girls	Total
Mastery	4	7	11
Performance	9	9	18
Total	13	16	29

3.7.3 Pre- and Post-Test

A pre and post-test with general food chain questions, as used by Luckin & Hammerton (2002), was administered in test conditions with support for reading where needed. Parts 1 and 2 were questions about a diagram of organisms, for example “prey = grasshopper; predator =?” The children needed to use the diagram to see that spiders eat grasshoppers. Part 3 of the test was designed to be a generalisation task as it was presented in an abstract format with letters on the diagram instead of actual organisms.

3.7.4 Procedure

The children were given a workbook to encourage exploration of the software. Children had two software sessions of equal length and content, but to allow comparisons between the two studies, data from the learner models was taken solely from the first software session. The second software session was the same as the first. The post-test was administered during the week following the second software session.

3.7.5 Results

As in Study 1, data was transformed into percentages (see Table 3.7). The homogeneity of variance assumption was $p = .055$ for two of our variables, percentage of help that was low level and percentage of help that was high level. ANOVA is

considered to be a “robust statistical procedure” so original data is reported, but these two variables should be interpreted with caution (Howell, 2006, pg. 316). There were no significant effects of gender on the data so this variable has been excluded from further analysis.

Table 3.7: Means (standard deviations) of children’s behaviour whilst using software

	Mastery (n = 11)	Performance (n = 18)
<u>Food Chains</u>		
Total no. food chains Attempted	19.82 (2.82)	19.39 (5.11)
Percentage of correct Food chains	53.64 (26.17)	43.33 (12.11)
Percentage of incorrect Food chains	46.36 (26.17)	56.67 (12.11)
<u>Clues</u>		
Clue Total	11.18 (6.23)	12.33 (3.29)
Percentage of Low-level Clues (1 and 2)	53.71 (41.96)	48.64 (29.08)
Percentage of High-level Clues (3 and 4)	46.29 (41.96)	51.36 (29.08)
<u>Two-link Food chain</u>		
Percentage of two-link Food chains attempted	98.55 (3.50)	97.94 (7.78)
Percentage of two-link Correct	54.18 (25.72)	43.89 (12.18)
Percentage of two-link Incorrect	45.82 (25.72)	56.11 (12.18)
Two-link low-level clue	5.18(4.53)	4.67 (3.18)
Two-link high-level clue	4.18 (5.33)	5.83 (3.81)

Table 7 cont:**Three-link Food chain**

Percentage of three-link Food chains attempted	1.45 (3.50)	2.06 (7.78)
Percentage of three-link Correct	.000	1.11 (4.71)
Percentage of three-link Incorrect	18.18 (40.45)	4.44 (18.86)
Three-link low-level clue	.18 (.60)	.22(.94)
Three-link high-level clue	.09 (.30)	.055 (.23)
<u>Post Clue Behaviour</u>		
Total % Clues Followed by Correct food chain	47.27 (26.48)	39.96 (14.98)
Total % Clues Followed by Wrong food chain	31.41 (18.34)	33.15 (14.94)
Total % Clues Followed by giving up	21.49 (17.95)	28.42 (9.88)
<hr/>		
<u>Views</u>		
Total No. of changes To Web View	7.45 (4.82)	7.72 (5.98)
Total No. of changes To energy view	5.36 (4.84)	5.83 (2.57)
Total No. of clicks On organisms	3.63 (5.50)	3.89 (4.90)

3.7.6 Food Chains

There were no significant differences between AGO groups for any of the food chain variables. Children selected very few of the harder three-link food chain actions regardless of their AGO.

3.7.7 Clues

The clue total was very similar between groups in this study, with mastery and performance-oriented children making a similar number of mistakes, $F(1, 27) = .390$, $p = ns$. There were no differences in clue level selection by AGO, $F(1, 27) = .145$, $p = ns$ for low-level clue selection and $F(1, 27) = .145$, $p = ns$ for high-level clue selection.

3.7.8 Post Clue Behaviour

There were also no significant differences by AGO in the behaviour following clue use (Table 3.8) and no significant differences in success of completing a food chain after receiving a clue. When looking at outcomes following selection of a high-level clue or a low-level clues, performance-oriented children were more likely than mastery-oriented children to give up after a low-level clue $F(1, 23) = 5.36$, $p < .05$, $r = .4$ (Table 3.8).

Table 3.8: Means (standard deviations) of clue outcome following a low- or high – level clue

	Mastery (n = 11)		Performance (n = 18)
% of low-level clues followed by giving Up (choosing different Organisms or action)	19.93 (19.19)	*	42.88 (25.91)
% of high-level clues followed by giving Up (choosing different Organisms or action)	12.36 (11.33)		15.81 (13.61)
* p < .05 significant differences between mastery and performance children			

3.7.9 Screen Views

There were no significant differences between groups in use of the different screen views.

3.8.0 Pre- and Post-test

A repeated-measures ANOVA indicated a significant increase between overall pre and post-test scores $F(1, 27) = 5.35, p < .05$, with a significant interaction with AGO, $F(1,27) = 4.49, p < .05$. This significant effect can be accounted for by differences between AGO groups in the pre-test scores. Mastery-oriented children scored significantly higher than performance-oriented children in the pre-test. An ANOVA by AGO on the pre-test scores demonstrated a significant effect of AGO on the pre-test as a whole $F(1,27) = 4.17, p < .05, r = .4$. As part 3 is specifically assessing children's ability to generalise, a further ANOVA was conducted on this separate part. This showed a difference by AGO with mastery-oriented children achieving a significantly higher score

than performance-oriented children, $F(1,27) = 7.12$, $p < .05$, $r = .5$ (see table 3.9). There was no significant effect of AGO on either the post-test as a whole or post-test part 3.

Table 3.9: Means and standard deviations of pre and post-test scores

	Pre Test (max 75)	Pre-Part (max 12)	3 Post-test (max 75)	Post- Part 3 (max 12)
Mastery				
-Oriented (n=11)	47.00 (14.59)	6.55 (2.91)	47.36 (13.62)	7.09 (2.21)
	*	*		
Performance				
-Oriented (n=18)	36.33 (13.06)	3.22 (3.44)	45.39 (12.89)	6.17 (3.31)

* $p < .05$ significant differences between mastery and performance children

3.8.1 Discussion

The changes made to the software for Study 2 were aimed at assessing learning gains between AGO groups using a comparable sample of school children. Results are consistent with the idea that increased metacognitive help such as additional audio and specific clues can enable all children to regulate their help-seeking behaviour. There are no differences in percentage of correct or incorrect chains, difficulty of food chain attempted, level of clue selected or type of screen view used. This suggests that all children used the features inherent within the software to equal advantage. Differences in Study 1, mastery-oriented children completing more correct food chains, mastery-oriented children attempting more three-link food chains and mastery-oriented children using the web view significantly more often, were not replicated in this second study.

One of the main differences between AGO groups in Study 1 was the number of three-link food chains correct and it is interesting that in Study 2 very few children of

either orientation attempted a three-link chain: it is unclear from the data why this might be. It is possible that presenting the task with a researcher rather than a teacher in the room meant that the task lacked personal relevance for a learning opportunity and therefore did not present mastery-oriented children with enough motivation to seek further challenge or that the children were not as able overall as children from Study 1.

In Study 1, mastery-oriented children showed several effective learning strategies which performance-oriented children did not use. They gained a higher percentage of correct food chains following a clue than performance-oriented children did. Mastery-oriented children appeared better able to generalise from the high-level clue to the food chain they were working on whereas the performance-oriented children tended to switch to a different action or different organisms. In Study 2 similar use of the software between AGO groups suggests that the addition of audio to the prompts and the rewording of the high-level clues added suitable support for performance-oriented children who were then able to seek help at a suitable level, and also to use this help to continue with the original food chain.

The only difference by AGO during the food chain task in Study 2 was that performance-oriented children switched to a new action or different organisms after selecting a low-level clue rather than a high-level clue as evident in Study 1. This suggests that the changed high-level clue format was equally helpful to all children regardless of AGO. The low-level clues encouraged further information seeking, (“click on the organisms for more information”) or general encouragement. Drawing on previous research, it is perhaps the lack of an actual answer that prompted performance-oriented children to switch rather than persevering; the high-level clues

were much more specific and children may have felt more assured of success therefore motivating them to continue (Dweck & Leggett, 1988; Pintrich, 2003; Hole & Crozier, 2007).

Adding a pre- and post-test to Study 2 has enabled further insights into the benefits of providing help-seeking support. The pre-test scores showed significant differences between the AGO groups, with mastery-oriented children scoring higher than performance-oriented children. The differences between groups disappeared in the post-test. This suggests that supporting performance-oriented children during their help-seeking has enabled them to seek information to aid their progress. It is possible that mastery-oriented children already used this skill, which would explain their stable test score between the pre and post-test. It is also possible that setting a pre-test primed children to a test condition thus causing a conflict between personal AGO and contextual AGO. This may have resulted in children responding in different ways during the task than they would normally do in a classroom situation, for example by selecting an easier option either because a performance-oriented context was salient or because the task did not present a learning opportunity. However the pre-test was conducted a week prior to the Ecolab II session and it is unlikely that any possible priming effects were transferred from the pre-test to the computer task.

3.8.2 General discussion

These two studies report behavioural differences between mastery- and performance-oriented children throughout a classroom task. The achievement goal measures we designed were successful in enabling us to compare help-seeking within the task we set. Collecting reliable, logged data throughout a classroom- based task enabled us to gain a clear demonstration that AGO predicts behavioural differences in

help-seeking and task behaviour. For example, mastery-oriented children tended to select low-level clues giving them a hint rather than the full solution and performance-oriented children had a propensity to give up more often after making a mistake and to avoid further challenge-seeking. In Study 1, mastery-oriented children made much fuller use of the software to gather information and add to their task knowledge. The two studies together indicate that when help-seeking is supported to encourage metacognitive awareness in a manner sympathetic to a child's AGO, all children can use help effectively to complete a task.

Study 1 post clue results suggest performance-oriented children give up on a task once help has been offered. We suggested this was because performance-oriented children had a problem generalising from the generic clue to a more specific example. Performance-oriented children also selected the high-level help for the easier food chain significantly more than mastery-oriented children did, suggesting that performance-oriented children prefer to go straight for an answer regardless of level of difficulty rather than follow suggestions to gather more information. Supporting help-seeking by adding metacognitive prompts encouraged task perseverance after an error had been made for performance-oriented children.

Study 2 used modified learning materials and showed no AGO outcome differences. Changes made to the software gave specific examples for the organisms rather than a generic example. This meant that children no longer had to generalise from the help they were given, which reduced differences between AGO groups. Importantly, results suggest that performance-oriented children were able to seek information more effectively within the post-test task to help them complete the questions. Few children in Study 2 attempted the more complicated three-link food

chains regardless of AGO. It is possible that presenting mastery-oriented children with a generic type of clue, as in Study 1, maintained task interest, as the children still had to apply this clue to their particular food chain. Altering this clue to a specific link, as in Study 2, removed this challenge and possibly demotivated mastery-oriented children. Nicholl's (1984) suggested that completing tasks with very little effort offers little intrinsic reward for mastery-oriented children. Therefore by making the clues more specific, the task may have appeared too easy which in turned reduced motivation for mastery-oriented children. Caution should therefore be used when tailoring help; as this study indicates, AGO groups seek information and use help in different ways. Results from Study 2 suggest that performance-oriented children benefit from metacognitive support within a software program, but that over-specific help may demotivate mastery-oriented children: more research is needed to clarify and extend this possibility.

This study highlights two important aspects of help-seeking behaviour. First is the importance of effective help-seeking by children, which allows children to realise when they require additional help. Second are ways in which children can be helped to use those strategies to apply new knowledge. This research adds to the understanding of differences in task-focused behaviour and supports the hypothesis that AGO influences help-seeking. The in-depth log of each child's task behaviour suggests a negative effect of inadequate help-seeking for performance-oriented children. These children have an inclination to give up on a task once they know they have made mistakes. As AGO influences help-seeking behaviour, the results suggest focusing on two skills; one, to seek relevant information and appropriate help and two, to generalise from that help to the process of problem solving and further tasks.

A limitation of these studies is that pre- and post-tests were not included in the first study, therefore we cannot directly compare the increased effectiveness of the metacognitive support in terms of learning gains between studies. The individual nature of the computer task may have also reduced the salience of performance-oriented goals, as there was no direct peer comparison. It should be noted though that although small numbers, performance-oriented pairs working as combined effort in study 1 showed no differences. A further limitation is that the method of profiling AGO is novel and further research needs to assess the robustness of this method of profiling children. Due to the novelty of this method, we have used a dichotomous profiling of either performance- or mastery-oriented children at separate ends of a continuum, but there are well-documented differences in effect between performance-approach and performance-avoidant goals as well as children holding multiple goal orientations (Pintrich, 2003). Further research should take these advances in theory into account when making a sensitive AGO measure for younger children.

These studies are important because they focus not only on *what* a child is learning, but by logging each task choice, also on *how* they are learning. By highlighting some of the help-seeking strategies children use to supplement their task knowledge, we have demonstrated how AGO may influence information-seeking, help use and classroom tasks. If help is inherent in a software program, it is only useful if children can incorporate this into their learning and persevere with their task. This study also raises the possibility that tailoring help specifically to accommodate a performance orientation may be detrimental to the challenge-seeking of mastery-oriented children. Children need to be able to use help in order to progress through tasks and improve their learning. Personalised learning can tailor support specifically

for different AGOs, thus accommodating the individual AGO. Further research should look at the effects of mastery-oriented classroom environments on performance-oriented children as well as specifically tailored metacognitive support.

4.0 Paper 2

Mathematics, Mastery and Metacognition: How adding a creative approach can support children in maths

Classroom instruction can influence personal goal orientations which in turn can influence how children approach and persist with a task. We hypothesise that using creativity to support a mastery-oriented approach within a mathematics curriculum encourages metacognition, improves motivation and persistence and helps children achieve an underlying understanding of mathematical concepts thus improving mathematics performance. Joint creativity supports a mastery-oriented approach by encouraging exploration of a topic and encouraging collaboration and discussion between peers.

This paper reports an eleven week project aiming to embed problem-solving strategies within a mastery-oriented whole-class environment to promote exploration, collaboration and a focus on the process of problem-solving. Participants were 24 children from a rural primary school in East Sussex, 12 boys and 12 girls (mean age 8 years and 9 months). The intervention led to increases in girls' perceived competence and motivation for mathematics and increased metacognitive reflection on learning strategies.

Keywords: mathematics, mastery-oriented, metacognition, problem-solving

4.1 Introduction

Motivation to participate in and complete school tasks is a fundamental component of school-based learning. However, children may have different motivations to complete a task. Achievement Goal Orientation (AGO) provides a framework to understand these differences (Dweck, & Leggett, 1988). This framework traditionally has a dichotomous split of mastery- and performance orientation. Mastery-oriented children appear better equipped to navigate their way through a problem maintaining task focus and perseverance, as the motivational focus is to understand (Meece, Anderman & Anderman, 2006; Grant & Dweck, 2003). Research suggests that a mastery orientation supports several educational attributes such as greater engagement, increased effort, perseverance, exploration, requesting appropriate help and seeking conceptual understanding (Ames, 1992; Pintrich, 2003; Elliott & Dweck, 2005). Performance-oriented learning may result in a more extrinsic, surface approach, the aim being to achieve a higher grade than a peer, rather than improve understanding (Church, Elliot & Gable, 2001; Hole & Crozier, 2007). When difficulties arise, children of the same ability but different AGO may respond differently, either progressing successfully, or faltering and swapping tasks (Dweck & Leggett, 1988). It is these differences which make it important to study AGO within a classroom environment. A performance-oriented child, who may be focused on finishing a task, being top of the class, or better than their peers, will have a different approach to a task than a mastery-oriented child who wants to work through the task gaining understanding and improving upon previous work. A performance-oriented student may seek a lesser challenge to achieve a high grade, or request a high level of help. Both students may achieve their goal, but the learning may be qualitatively

different. For example, a mastery-oriented child may be more prepared to persevere with a problem and by shifting strategies in an effort to complete the task may also learn strategies which can be transferred to a future task. A performance-oriented child may have asked for a high degree of help, completed the current task to the same grade as the mastery-oriented child, but has not gained an underlying understanding of the task. On future tasks, the performance-oriented child may have a strategy of help-seeking, but not a strategy for understanding and working out (Pintrich, 2003).

Mastery-oriented children, who are intrinsically motivated, show greater sustained levels of metacognitive awareness (Ford, Smith, Weissbein & Gully, 1998). Metacognition is an awareness of your own thinking and involves self-reflection, ability to plan and monitor progress, adapt strategies and maintain task focus (Ford et al, 1998). Discussion between peers plays an important role in learning and development of such metacognitive skill. Vygotsky (1978) believed that language is used as a cognitive tool enabling knowledge to be shared as well as understood. Brown (1988) suggested that children consolidate their learning more effectively when they have to explain and justify their choices, therefore using language to support their understanding. AGO may influence task conversation and in turn influence how learning is consolidated. Children who simply repeat a question or are concerned with other children's progress may not increase their understanding or use their metacognitive skills to reflect on and monitor their learning. Children who ask questions and justify their responses to a peer can consolidate and extend their understanding (Solomon & Black, 2009). Vygotsky posited that children's self-regulation and metacognitive ability arises first of all from discussion with peers, in the

attempt to project one's own argument, before this process moves to an internal mental state and an ability to self-reflect and problem solve (Vygotsky, 1978). Performance-oriented children who are concerned with achieving a higher grade than their peers may concentrate on concrete knowledge and fail to explore uncertainties in their learning and therefore limit their understanding. In contrast, mastery-oriented children may elaborate on the task by trying to add information to the question and consider different learning strategies to accomplish their task, because their motivation is to improve their understanding (Harris, Yuill & Luckin, 2008; Pintrich, 1999). Mastery-oriented children may also be more aware and more willing to express a lack of understanding which in turn should prompt these children to seek clarification and help (Chi & Bassok, 1989).

4.2 Classroom learning

An important educational consideration is that differences in motivation affect children's strategy use and this in turn is influenced by the instructions they receive for a task (Matthews and Rittle-Johnson, 2009; Harris, Yuill & Luckin, 2008). Instructions which emphasise a performance-oriented focus on evaluation and competition influence the way children approach a task (Church et al, 2001; Meece et al, 2006). Children receiving performance-oriented instructions in a study by Harris et al (2008) tended to concentrate more on the task outcome, gaining the most points, than on spending time discussing good solutions and strategies. This focus on the outcome, in turn, affects the strategies employed throughout the task with a performance-oriented focus on public success leading to more requests for the answer and less time trying to work it out (Ford, Smith, Weissbein, Gully & Salas, 1998; Harris et al, 2008). A mastery-oriented focus encourages the idea that success stems from effort therefore

promoting perseverance and interest. Classroom instructions which focus on improvement, encourage questions, discussion, exploration and experimentation promote a mastery-oriented approach (Ames, 1992; Church et al, 2001). Instructions which encourage children to concentrate on the process of the task rather than the end result leads to increased effort and perseverance and ultimately improved learning (Schuitema, Peetsma and Van Der Veen, 2011).

4.3 Mathematics learning

Mathematics does not intrinsically lend itself to a mastery-oriented approach and is generally perceived as having one correct answer for each mathematics problem. Children may consequently format their answers using procedural knowledge for problem-solving rather than try different strategies and expand their own ideas; a common misperception is that one process leads to one answer which discourages exploration (McNeil & Alibali, 2000; Solomon & Black, 2009). Mathematics anxiety and concern with mathematical ability can interfere with a child's concentration as intrusive "I can't do it" thoughts undermine concentration on the task and become a self-fulfilling prophecy (Furner & Gonzalez-DeHass, 2011; Ashcraft, 2002). Being confident to try alternative strategies and asking questions in a whole class environment can be daunting. A classroom focus on evaluation orients the learner towards comparison with peers and classroom hierarchy, more in line with a performance-oriented AGO (Church, Elliott & Gable, 2001). A mastery-oriented environment focuses on the process of problem-solving and therefore encourages improvement; mistakes are viewed as a valuable learning opportunity rather than a failure (Furner & Gonzalez-DeHass, 2011). Creating a mastery-oriented atmosphere where collaboration, enquiry, exploration and self-reflection is encouraged can lead to increased confidence, greater effort and

sustained engagement (Blumenfeld et al, 1991; Turner et al, 1998).

The purpose of the current study is to explore a mastery-oriented approach to learning mathematics, increase metacognitive reflection and improve perseverance. Using mathematics within a creative project removes the focus on evaluation and encourages children to try different strategies to solve problems. This is more reflective of a mastery-oriented approach to learning and allows students to support each other's exploration with discussion and active involvement with a relevant task (Furner & Gonzalez-Dehass, 2011). This approach to learning mathematics echoes the aim of the UK Nuffield Mathematics Project; 5-11(Nuffield Foundation). This started in the 1960s and aimed to incorporate children's own experiences into mathematics teaching with an emphasis on learning, understanding and context and a move away from procedural learning. The course was designed to encourage children to explore their own thoughts with guidance rather than direction from the teacher and led to the project slogan *"I do – and I understand"*.

The current study seeks to promote this philosophy and maintain a mastery-oriented focus throughout, encouraging children to focus on the process of problem-solving in a creative and flexible manner.

4.4 Creative Partnerships Enquiry Schools Programme

The Enquiry schools project addresses a specific question from the school requiring in-depth collaborative planning between CP, the practitioner and the school. The school defined their enquiry question as "How can creative approaches enable children to contribute to their learning development?" The aim of the project was to bring creativity to bear on problem-solving strategies within a mathematics environment. By working closely with a class teacher it is hoped that pupils, teachers and

practitioners will become “co-constructors” of a learning programme that will lead to sustainable engagement. By using the skills of an external practitioner, for example a visual artist or a filmmaker, it is hoped that fresh ideas and approaches will be introduced to established teaching and learning.

To encourage engagement with the processes involved in solving mathematics problems and to support children in using mathematics in unique ways, the mathematics activity was made cross-curricular by linking with the class topic of Ancient Egyptians. The children were instructed to research, design and make canopic jars alongside a visual artist. It was proposed that a mastery-oriented approach alongside a high level of involvement with the task would help the children reflect on what problem-solving strategies were working. The visual artist encouraged discussion between the children regarding their design, size and materials. This was initiated with a “brainstorm” session with the children suggesting ideas and the visual artist writing them on a large piece of paper. The merits of each idea were discussed and then a vote taken by the children as to which design they wished to make. *“Talkis perhaps the most important means for ensuring that a student’s engagement in a series of activities contributes to their developing understanding of science, mathematics or any other subject as a whole.”*(Mercer, 2008, pg.5).

By using mathematical processes outside a typical mathematics lesson, it was anticipated that children would gain confidence in trying different strategies. The aim was to move away from the expectation that learning was about finding the right answer and to encourage each child’s metacognitive thinking in the form of reflection and evaluation.

Embedding learning within a creative project promotes engagement with

content, encourages collaboration and fosters exploration of learning strategies. By using mathematics problem-solving to complete their creative project, children use mathematics in context and learn how to apply mathematical concepts outside the traditional mathematics classroom (Furner & Gonzalez-DeHass, 2011).

4.5 Method

The project was a collaboration between the school and Creative Partnerships. The school employed the author of this paper to evaluate the project, following British Psychological ethical Guidelines and to report results to both Creative Partnerships, the school staff and parents. To enable this, the researcher interviewed children at the beginning and end of the project, asked children to complete a mathematics evaluation scale both at the beginning and end of the project and asked the class teacher to set the children mathematics words problems as a pre- and post – test so as to assess any learning gains (appendix 8.2.1).

4.5.1 Participants

Participants were 24 Year 4 children (12 boys and 12 girls mean age 8:9) attending a semi-rural primary school in East Sussex. Parents were informed about the project by the school and parental consent for the researcher to interview the children and use data from the study was obtained prior to the study commencing. Children were asked if they would like to chat with the researcher and told that they did not have to if they would rather not. All children chose to participate. The project was funded by Creative Partnerships due to a successful bid by the school and ran over a period of eleven weeks with one day a week dedicated to it.

4.6 Measures

4.6.1 Metacognitive reflection

Children were interviewed for ten minutes in groups of 3 at the start of the project, prior to the creative activity to gather information about the level of awareness of different learning strategies. The researcher asked “What advice could you offer someone as a learner?” This was to encourage the children to think about their own learning strategies. This interview was repeated at the end of the study with the same groups of 3.

4.6.2 Mathematics Evaluation Scales

Children completed two five-point mathematics evaluation scales assessing motivation and competence at the start of the project before any creative intervention or mathematics work had taken place. The first scale was to record how intrinsically motivated children were about mathematics as a subject with a 5-point scale and two statements; one end with a score of 1, sad face picture— I don’t like mathematics at all, to the other end, score of 5, happy face picture— I love mathematics. The second scale was to assess perceived level of competence, again with two statements and five points; one end, sad face picture – I’m not very good at mathematics, to the other end, happy face picture – I’m really good at mathematics. Children marked where they felt they were along the scale with the middle being explained as “just ok, not sad or happy”. These evaluation scales were repeated at the end of the study.

4.6.3 Mathematics Performance

At the start of the project, prior to any creative intervention, children completed ten traditional mathematics word problems set by the class teacher and were scored for the number of correct answers and the number of methods displayed.

For example; Toby has 42 eggs. Each egg box holds 6 eggs. How many egg boxes will Toby need to hold all the eggs? Displaying methods whilst working out word problems would indicate an understanding of the process. The children completed these individually in test conditions. The same paper was sat at the end of the eleven week study in the same test conditions. One boy did not complete the pre-test and one girl did not complete the post-test due to school absence, therefore they have been omitted from any analysis. These two children took part in the main creative project and mathematics sessions so they are included in the group numbers.

4.7 Procedure

To fulfil both the mathematics and Egyptian parts of the project the children designed and made canopic jars. The children worked with the visual artist to create their designs and discussed concepts such as circumference and capacity whilst researching suitable materials, quantities and designs.

To encourage children's autonomy throughout the project, the jar design was achieved through group discussion with each child putting forward ideas. It was important to acknowledge the children's ideas and more importantly show that their decisions were incorporated into the project. Autonomy leads to higher levels of interest, engagement and enjoyment and consequently higher levels of achievement (Gagné, Koestner & Zuckerman, 2000). The children worked in small groups to discuss ideas and were brought back as a larger group periodically to share, refine and question these ideas alongside their classmates and visual artist.

The children were split into two groups and remained in these groups for the length of the project. The project ran one day a week for eleven weeks. Each group worked for half a day in each session and then swapped so that both groups had a creative session and a mathematics session each week. In the creative session, children

worked on the canopic jar design and making their designs and in the mathematics session, children took part in a more formal mathematics session followed by a group discussion.

The children had to solve a range of mathematics word problems. The teacher wrote these problems based on the children's ideas generated during the creative sessions. One group had decided to make a large hexagonal shape for their jar out of plywood so the class teacher wrote specific word problems based on these ideas. For example, one of the problems read "Your pot is going to be made out of 6 plywood rectangles. Each rectangle will measure 20cm x 45 cm. Plywood is sold in 100 x 100cm squares. How many pieces of plywood will you need to buy to make your pot?" This made the word problems very specific to the children's creative project and enabled the children to work out how much material they would need in order to complete their designs. This provided both context and relevance for the mathematical process.

In 2010, the UK government Department for Children, Schools and Families (DCSF) guide for parents states "mathematics is an imaginative, creative way of thinking which is part of everyday living" (DCSF, 2010). In the creative sessions the children explored mathematical concepts, such as scale, circumference and capacity, in a creative way to encourage understanding of the underlying principle. For example when measuring the capacity of their trial pots each child filled their pot with different objects such as pencils, modelling clay or building blocks and then recorded how many were in the pot. This encouraged the children to think about and understand exactly what "capacity" meant. The children were then able to discuss with confidence the capacity they would require of their canopic jars, they could think about the purpose of their jar, what would be required to go into it and this term became conceptually

meaningful. The project was child-led with the children choosing their designs for the jars, leading discussions and finding the mathematical methods which were most intuitive for them. Some children chose to sit with a pen and paper and make calculations, others chose small blocks to physically represent the numbers involved, whilst others chose a times table square depicting all the tables as a prompt to enable calculations. The emphasis was on the process of problem-solving rather than the end result.

Early in the project the children explored different shapes for their pots using newspaper and sticky tape. The visual artist had a specific reason for this which steered the children towards a mastery-oriented approach;

“If you use craft paper and let a child take their pot home, they start thinking differently about it, they start making it for someone else and become less confident about trying different things, less sure about making mistakes”.

It was important that the children understood the processes they were using to solve the word problems, enabling them to reflect on their learning and understand why they could, or could not, do something and more importantly that they could try again.

Research has shown that failing to understand a question may lead to lack of perseverance, less useful help-seeking and reduced self-esteem (Bereby-Meyer, Moran & Unger-Aviram, 2004; Luckin & Hammerton, 2002). To encourage the children to persevere and seek understanding during the formal mathematics sessions, each child was given a “Helping Hints” card with specific actions to encourage perseverance.

- 1) I can read through the problem again
- 2) I can find something in the classroom to help me.
- 3) I can listen to my partner's ideas.
- 4) I can think about similar problems I have solved

These were to offer prompts when the children reached the “just can’t do it” stage when they sometimes concentrate on a lack of understanding rather than thinking of ways to progress. Early on, one child became unable to find a way forward and when asked what she could do next, her reply-- “give up?” -- indicated that offering a strategy to encourage perseverance would be beneficial.

Using displays within the classroom such as a times table chart, number line, blocks or drawings to help work out a problem may provide a context that the child can understand. Whilst discussing methods one child commented that they thought using the usual classroom displays would be “cheating and [the teacher] puts them there to test us”. The teacher found this discussion valuable as the purpose of the displays is to provide prompts for the children. It was useful for the teacher to then lead into a discussion of possible help which could be sought within the classroom. Listening to a partner's ideas encourages the children to put their thoughts into words as well as to listen to an alternative perspective. Thinking about similar problems they have solved is a positive statement focusing the children on the calculation within the mathematics problem. It was hoped that the children could then work towards an answer and more importantly, to understand how they arrived at that answer. The “helping hints” were to encourage the children to reflect on what they knew and inspire them to think of different strategies for problem-solving.

The emphasis of the lessons was on the methods the children used to find

answers. After each session there was a group discussion in which the children discussed how they had arrived at solutions. One particular session saw 9 different ways to solve the same problem, all of which arrived at the same (correct) answer. There were also discussions after the creative sessions in which the children talked about what they thought they had learnt. These discussion sessions were predominantly the children talking, with the focus being to discuss methods rather than answers.

4.8 Results

4.8.1 Metacognitive reflection

The responses to the initial interviews were grouped semantically which resulted in three common themes;

- 1) Work as a team
 - a. For example, "We should work together", "You can use teamwork".
- 2) Listen to the teacher
 - a. For example, "The teacher will tell you what to do, so you have to listen to that", "You need to listen to the teacher"
- 3) Talk to each other
 - a. For example, "You can talk to your partner", "You can talk on your table"

The majority of children made the same responses which may reflect teacher prompts and general classroom expectations rather than an understanding of their individual learning strategies.

During the final interviews, the researcher repeated the same question to the children "What advice could you offer someone as a learner?" The children's advice

offered in the final interviews contrasts with the initial interviews and shows some insightful knowledge about each child's own learning. The comments were more diverse and did not fit into the initial three categories. The children appeared more able to suggest particular strategies and the comments were individual to each child and more reflective of each child's learning journey. When the advice did fit into one of the initial three categories, for example no. 2 (listen to the teacher), no. 3 (work as a team) and no.6 (talk to each other), it was more specific and detailed. Some further examples from the groups are included;

- 1) To be patient
- 2) To wait and listen [to the teacher] before starting
- 3) To not argue over partners – it doesn't matter who you work with
- 4) It is ok if you don't get it right first time, but don't give up
- 5) To try another idea if the first one doesn't work
- 6) To listen to someone else's idea because you can add them together
- 7) It is ok to ask for help if you get stuck
- 8) Use lots of different things to help you

4.8.2 Mathematics Evaluation Scales

Girls ($Mdn = 3$) differed from boys at the beginning of the project as rating themselves less competent than boys ($Mdn = 4$) at mathematics, $U = 15.50$, $p < .005$, $r = -.66$. Boys ($Mdn = 4$) also scored higher on motivation than girls ($Mdn = 3$), $U = 25.5$, $p < .01$, $r = -.52$. There were no significant differences between boys and girls for either of these variables on the post-intervention evaluation scales.

A Wilcoxon test on pre and post measures showed that there was not a significant difference between boys' opinions on either scale, but there was an increase in the

girls' (*Mdn* 3) motivation evaluation between pre and post-test, $T = 3$, $p < .05$, $r = -.46$.

4.8.3 Mathematics Performance

A repeated measures analysis of variance on mathematics performance was conducted which, as one might expect, showed a significant improvement in scores, $F(1,20) = 13.40$, $p < .01$. (Table 4.1). More crucially, there were significantly more methods displayed by the children on their post-test paper than on the pre-test, $F(1,20) = 59.06$, $p < .001$. There were no gender differences in these results and all analysis satisfied assumptions of sphericity.

Table 4.1: Means (standard deviations) of Mathematics Performance

	<i>N</i> = 22
Mathematics Performance	
<i>Beginning of Project</i>	
Number Correct	5.05 (1.84)
Method Displayed	2.23 (.97)
<i>End of Project</i>	
Number Correct	5.73 (2.0)*
Method Displayed	3.45 (.86)*

* $p < .01$. Significant differences between pre and post-test mathematics performance

4.9 Discussion

Children improved their mathematics skills through the course of the project. More significantly for the project, they showed a better understanding of the importance of displaying methods, and more individually-developed metacognitive

reflections on learning. These improvements were also accompanied, for girls, by an increase in perceived competence and liking for mathematics.

The boys' opinion of their mathematics ability was concordant with their initial mathematics performance results whereas girls underestimated their ability. These results are supported by previous research, which indicates that girls generally achieve slightly more than boys during primary school yet boys tend to have more positive competence beliefs about their ability (Eccles, Wigfield, Harold & Blumenfeld, 1993). Mathematics anxiety is also higher amongst girls than boys (Ashcraft, 2002). As there was no control group, it is not possible to estimate how much improvement was due specifically to this project, however, it is encouraging that difference between boys and girls on their perceived competence and motivation for mathematics had disappeared by post-intervention evaluation.

Initially, some children wanted defined parameters rather than an open-ended creative task. They wanted to know exactly what was expected and did not seem keen to draw on inner resources or imagination. By taking the creative work out of the classroom and working with a visual artist, the children felt freer to experiment and "trial and error" became "trial and improvement". Children became much more accepting of "trying things out" as the project progressed. Focusing on evaluation increases the salience of performance-oriented goals which in turn increases an evaluation of self in comparison to peers (Church, Elliott & Gable, 2001). If girls felt that they were less competent at mathematics, they would evaluate their ability less favourably. Focusing on strategy use encouraged an underlying understanding of the mathematical process and this may have contributed to the change in girls perceived competence and in turn their liking for mathematics as a subject.

During the classroom mathematics sessions the children worked in pairs and approached the questions with enthusiasm. The class teacher encouraged the children to find things in the classroom that would help them work out the answers. The teacher's aim was to also motivate the children within the more formal classroom structure and for the children to feel that it was ok just to have a go, even in a subject such as mathematics. One particular child commented at the beginning of the project;

"Learning with [the visual artist] is fun because you can do it in rough, you don't have to worry about making mistakes....can't do mathematics like that, have to be right"

Promoting a whole classroom mastery-oriented environment can encourage children to focus on exploration and understanding of their learning process. Mastery goals promote greater learner unity and a willingness to cooperate with a partner as the focus is on learning, exploring and trying things out and less on judging your ability against that of another (Ames, 1992). The children appeared to have embraced this opportunity throughout the project and despite initial reservations about having no set parameters, the class worked effectively together to research and produce their designs. The creativity, cooperation and discussion led to greater problem-solving strategies in the mathematics post-test and more reflective and personal learning advice. The metacognitive reflections in the final interviews are very different to the initial interviews in both quality and quantity of response. This indicates much greater thought from each child about their own individual learning strategies indicating that the learning has more personal meaning to the child. This is concordant with the AGO literature which suggests that mastery-oriented learning promotes task focus, strategy use, persistence and self-regulation (Meece, Anderman & Anderman, 2006; Grant &

Dweck, 2003; Ames, 1992) and in turn, intrinsic motivation, as encouraged by mastery-oriented learning, is related to higher levels of metacognitive awareness.

Working in groups or with partners stimulates discussion and changes the focus from ability and hierarchy. Cross-curricular projects make the subject more fun and accessible for all abilities. As well as encouraging a fundamental understanding of the mathematical concept behind the canopic jars and word problems, this project appears to have had a particular impact on the girls' mathematics opinions. The girls rated themselves post-test as more confident about their mathematical ability as well as reporting an increased liking of mathematics as a subject. This rating post-test was comparable to the boys rating whereas pre-test boys had displayed greater mathematics confidence than the girls.

This age group were extremely receptive to the creativity of the project and accepted both a creative and a more formal mathematics way of working. Children of all abilities were able to access the creative session and working in pairs during the formal mathematics sessions also meant that all children were able to discuss their strategies and plans without feeling under pressure from a whole class environment. Encouragement to try different strategies, talk with partners and time to discuss the activity as a group had an impact on an important aspect of learning, mathematics confidence, as well as the end test results. Embedding a mastery-oriented attitude to learning, when children appear to be receptive both to group work and creative projects, may help reduce mathematics anxiety and increase feelings of mathematical competence which in turn will encourage exploration and understanding of mathematical concepts giving rise to further confidence. However, setting aside a whole day for mathematics may not be achievable within a prescriptive, performance

driven curriculum. Adding such a creative aspect required additional resources which may not be available without external funding, such as this project was fortunate enough to obtain.

A limitation of this project is that it is not easy to see which variables had the main influence on changing girls' mathematics opinions or the success of concentrating on the processes involved in solving mathematics word problems. It is possible that it was the amalgamation of approaches that ensured the success of the project, or solely the creative activity. Many children did not realise they were "doing" mathematics with the visual artist until the class discussion highlighted that fact. The relaxed atmosphere of the creative sessions allowed the children to set the pace, thus encouraging exploration, discussion and experimentation. Linking this work with mathematics may have helped alleviate typical mathematical worry and allowed all children to contribute ideas and thoughts freely. The atmosphere and the way mathematics was embedded within creativity may have contributed to the rise in girls' opinion both of mathematics as a subject as well as their mathematics ability. The creative project gave the word problems context, and gave the children concrete examples, enabling them to discuss the underlying mathematical process with increased confidence. The group discussions allowed the class to add ideas together and explore learning. These discussions also gave the teacher opportunity to highlight particular areas of interest to consolidate learning and to ensure that the class were reaching understanding. Giving the children prompt cards with "helping hints" gave them a strategy when they became stuck and also encouraged the children to think about the process of problem-solving. This helped to maintain a mastery-oriented classroom approach throughout both the creative activity and the classroom

mathematics by supporting children's exploration and perseverance. Experimenting with different methods and tools helped them work out their calculations and gave the children more choice over their learning. Having choice in this manner allows children to plan and adapt their actions to the task and being able to do this successfully is a crucial aspect of self-regulated learning and metacognitive skill (Postholm, 2010).

The teacher reported that she thoroughly enjoyed the project and she suggested that the level of engagement of the children within the project had a positive impact on their attitude to mathematics and their learning. The project gave the children context and a purpose in which to use their mathematics skills. The completion of the project also encouraged the teacher to look at ways in which creative approaches can be used in other areas of the curriculum. To work creatively consistently would present its own challenges. For example, being able to split the class into two groups was ideal, but not always feasible given time and space constraints present in many schools. A further challenge is to ensure that areas of the curriculum which need to be more formally taught are done so, whilst incorporating creativity to allow children exploration time.

5.0 Conclusion

Challenging children's perceptions of mathematics and encouraging them to think about the problem-solving process rather than an end result allows them to be more flexible in their learning and to find methods that suit them. *"Children learn mathematics best through tasks where they have to make choices in order to solve a problem or puzzle"* (DCSF, 2010). Allowing children to contribute so much to their own learning encourages feelings of autonomy, which is important for increased interest and perseverance (Gagné et al, 2000).

The next research stages are to concentrate on metacognitive reflection and to look at longevity of success with a follow-up test. This has so far only been done anecdotally with the class teacher who feels that her class are now much more likely to discuss mathematics problems.

This project was an enjoyable, informative and challenging experience. It challenged the teacher and the children. The teacher found that occasionally taking a step back to watch the children working with the visual artist gave her new insight into their learning which she could incorporate into future lessons. Both the teacher and children concentrated on the process of problem-solving which encouraged flexibility. One of the main reasons that this was a successful project was the willingness of the school and particularly the class teacher to take a step back, not plan an outcome and just see where the process went.

5.1 Acknowledgements

I am grateful to Sophie Watkiss (Creative Partnerships), Lulu Allison (Visual Artist) and Mrs Russell and Mrs Peirson of Herstmonceux Church of England Primary school for allowing me the opportunity to work alongside them and Year 4 throughout this hugely enjoyable project. This project was made possible due to a collaboration between Herstmonceux Church of England Primary School and Creative Partnerships funded Enquiry Schools programme

5.2 Creative Partnerships Enquiry Schools Programme

This project was funded by Creative Partnerships Sussex and Surrey, which was part of the Centre for Community Engagement at the University of Sussex. Creative Partnerships was a programme funded in turn by the national organisation Creativity, Culture and Education (CCE). Creative Partnerships (CP) aims to inspire creativity in the

classroom by matching the skills of an external practitioner to the needs of a school.

6.0 Thesis Conclusion

In order to learn and progress in the classroom, children need to take risks, for example, putting up their hands to answer a question, without absolute certainty that it is the right answer, or trying a more difficult task without knowing whether they will succeed or not. To enable children to do this, we need to recognise motivational conflicts, such as knowing help is needed versus being unwilling to acknowledge this, and to provide appropriate, accessible support. In recognising and understanding the different underlying motivations it becomes possible to accommodate the influences of AGO and assist children to reach their full potential. This thesis has investigated differences in the ways children with different motivations approach their learning through help-seeking. The research presented in this thesis adds to the literature on AGO and further establish the differentiated motivations behind children's help-seeking and task choices. We then investigate ways in which children's learning might be supported with whole-class approaches. The two papers presented in this thesis report the process of learning as well as outcome measures.

6.1 AGO Diagram

The diagram below represents a simplified description of the influence of AGO on learning. The flowchart shows points where children may become stuck when progressing through a task if they are unwilling to seek help, seek inappropriate help or lack metacognitive support.

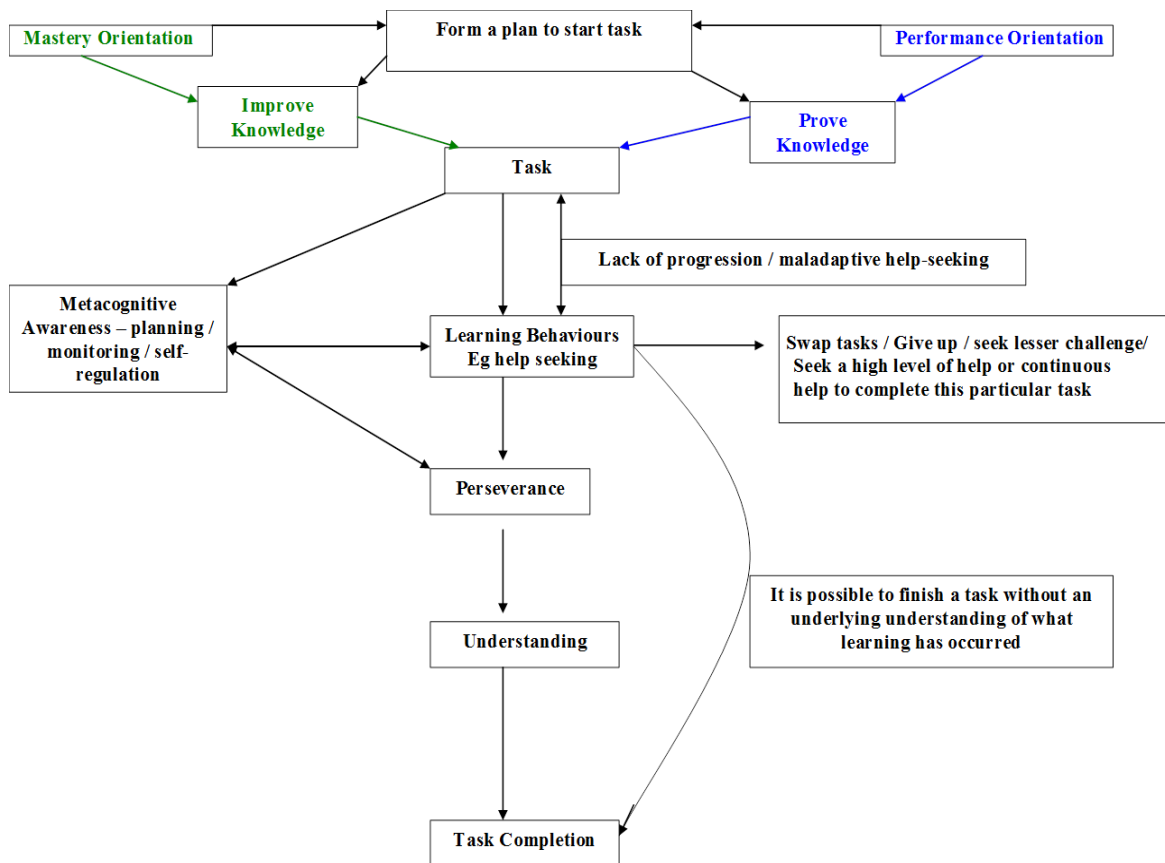


Figure 6.1: AGO diagram indicating learning process from start to completion.

Important metacognitive strategies such as monitoring and self-regulation may help supplement external task information. For example in Paper 1, the different screen views represented external task information. Children monitoring their progress noticed they needed further information to complete their food chains and used the external information presented in the screen views to help them. Children unaware of this external information, or not monitoring their work struggled and chose instead to swap organisms or chose an easier food chain action either becoming stuck between task and learning behaviours or else possibly completing the task without first gaining underlying understanding.

Adding metacognitive support, as in paper 1, at the help-seeking stage may encourage children to carry on with a task and focus on the process of learning.

Alternatively, providing a context in which all children feel able to explore their resources, as in paper 2, can encourage exploration of the process of problem-solving and seeking alternative means of support such as peers. These may lead to greater perseverance, more appropriate help-seeking and in turn, deeper understanding and increased confidence in one's own ability.

The first paper investigates differences in children's help-seeking behaviour using software supporting learning about ecology and then extends this research to investigate the effects of a tailored approach of providing metacognitive support within the same task. The second paper reports the effects of a whole-class mastery-oriented approach on children's perceived competence and motivation in mathematics. By focusing on the process of mathematical problem-solving, this paper shows changes in children's metacognitive reflection pre- and post-intervention.

A challenge presented by some previous AGO literature is the difficulty of extending results from an experimental self-report method on older students in order to draw conclusions regarding the learning behaviour of younger children within the context of the classroom. A strength of this research is the data collection of children's behaviour as it occurs during classroom-based curriculum tasks. Both studies provide a rich qualitative resource as well as quantitative data within which to investigate children's actual learning behaviour.

6.2 Paper 1

Qualitative answers during the interviews in paper 1 have provided a wealth of information upon which to base categorisation and have given insight into children's thinking behind their tasks choices. For example, asking children why they would

choose a particular task, rather than just relying on the choice of task itself, has allowed for further understanding in children's AGO thinking. Comments from the children interviewed for paper 1 such as *"Even if I'm wrong I can still learn something"* and *"I like to show I know the answer, if one comes up that I definitely know I put my hand up"* illustrate differences in thinking even when the action is the same (i.e. putting a hand up in class).

In paper 1 we collected data by logging children's learning behaviour throughout a computer task using software supporting learning about ecology. This allowed for insight into children's actions and the strategies used whilst working through a task. Ecolab II, the science task, offered different levels of help as well as further information which could be sought from the program. Children choose an action, for example "Eats and is eaten by", and then select organisms with which to complete this task such as "Tadpole eats pondweed and is eaten by stickleback". Some children focus on the end result, what they have to present, rather than the process of information gathering, whereas some children become absorbed in finding out about the different organisms and their hierarchy in relation to other organisms. By logging children's actions, we could see which combination of organisms children choose, whether they tried to build a food chain with the same organisms each time or whether the children swapped between organisms and actions. The computer system also logged which resources within the program, such as the screen view, children were using along the way.

Ecolab II offers automated help to aid task completion. The different levels of help offered prompts the child to consider their next action and seek further information such as looking at screen views or the organisms in more depth, or use the

help to rearrange the order of the selected organism. The software logged what level of help children selected and whether children used the help, ignored it or chose further help. Analysis of this data suggested that performance-oriented children selected higher levels of help than mastery-oriented children but then appeared unwilling or unable to use the help and so swapped to something less challenging. By swapping to another combination of organisms, children were not attempting to apply their selected help to a problem or think through what else might be helpful. Mastery-oriented children appeared better able to continue with their original task through to completion, regardless of which help they selected. Children with different AGOs therefore showed differences in their ability to use the help inherent within the program. Mastery-oriented children made greater use of the alternative screen views to gather information for their task. By making greater use of the help inherent in the program, mastery-oriented children appeared better able to consider processes which may lead to success, i.e. further exploration.

Because of the differences highlighted in Study 1, several metacognitive adjustments were made to the software for study 2; rewording the high-level clue to be specific to the child's task choice, adding audio to make the information more salient and giving children a paper workbook to refer to. A pre - and post-test was also added in order to measure learning gains.

The pre-tests suggested that there were some differences between mastery- and performance-oriented children in this study. These differences disappeared by the post-test which is consistent with the idea of a tailored approach increasing metacognitive support within the program. However, despite these differences in the pre- and post-test data, there were no differences between the children's actions and

task choices in the Ecolab II logged data, thus presenting an inconclusive picture. The behaviour recorded in Study 1, for example mastery-oriented children choosing a greater percentage of the more challenging food chains, using the screen views more successfully and not selecting the higher level clue as often as performance-oriented children, were not replicated in Study 2. All children completed a similar percentage of food chains, selected a similar amount of help and chose a similar level of challenge. Performance-oriented children showed a comparable lack of perseverance in Study 2 as in Study 1. However in Study 2, a lack of perseverance was evident after performance-oriented children had received a low-level rather than a high-level clue, the opposite pattern to Study 1. The low-level clue offered very general encouragement *“that’s not quite right. Have another go, I’m sure you can do it”*. These two studies suggest that performance-oriented children were seeking specific help to enable them to finish the task. The high-level clue in Study 2 was specific to the organisms the child was working with which may be why there was less evidence of children swapping organisms in this study as opposed to Study 1. This is concordant with AGO research suggesting that performance-oriented children seek quicker and more explicit help in order to finish a task competently and possibly with the added attraction of finishing first (Newman, 1998).

These studies indicate that being able to ask for help is not enough. Performance-oriented children given generic or very general information appeared unwilling or unable to continue, swapping instead to an easier task. Mastery-oriented children on the other hand tended to persevere with the same task after clue selection, suggesting that they were better able than performance-oriented children to

use the help they had sought and were not necessarily looking for specific, detailed answers.

By logging the occasions that children received help, but did not use it, these studies suggest that metacognitive difficulties are not necessarily to do with children failing to monitor their work efficiently in order to recognise a need for help, more with knowing what to do with help received when it is more general than they wanted. Even when help was explicitly available and the appropriate clue level to choose highlighted for a child via audio and screen prompts, performance-oriented children did not take advantage of this to enhance their progress. They appear to prefer to swap tasks and even repeat the same actions in order to fulfil the task. This does get the task completed, but does not appear to enable children to progress to more challenging tasks and extend their learning.

Paper 1 suggests the kind of support that may be useful to individual children. The metacognitive support inherent in the program encouraged children to request help. Children were also prompted to request an appropriate level of help; this could have been especially useful to the child in moderating tendencies for too much or too little help. Inherent metacognitive support which may be useful to children includes adding audio to increase the salience of clues and prompts to use available resources (screen views) for information gathering. Our results also suggest ways in which feedback can influence behaviour motivated by different AGOs. It is possible that over specific help offered by the high-level clue in Study 2, whilst supporting performance-oriented children, did not present enough interest to motivate mastery-oriented children. In Study 1 high-level clues were too general and did not support performance-oriented children to persevere. These differences highlight potential

problems of balancing the needs of children with different AGOs in the same classroom.

These two studies have also raised potential difficulties with a tailored support approach. By tailoring metacognitive support to help performance-oriented children to recognise and access help in a task, challenge and interest might have been reduced for mastery-oriented children. Making help more salient did not appear to encourage added exploration and challenge seeking by performance-oriented children. Future directions for such research may involve offering support tailored specifically to either a mastery-oriented or performance-oriented approach rather than trying to make the generic help which is available to all children more accessible specifically for performance-oriented children. It is possible that such help also needs to be adapted specifically for mastery-oriented children to maintain interest and engagement.

Personal and contextual factors such as AGO and classroom focus are both indicated in a child's decision to request help and the interaction between these need to be taken into consideration when creating a supportive learning environment. The way a child views their own competence is balanced with their motivation for completing a task and the expectations they have about the environment (Ryan et al., 2001). Therefore, creating a classroom environment which facilitates discussion, sharing of ideas and which values effort alongside grades may be easier for a teacher than providing individually-tailored AGO support. A mastery-oriented classroom context may be more successful than individual tailored support in encouraging effortful behaviour. Such a context may give children greater confidence in "having a go" and just trying a process as the perceived focus of the classroom will be on the process of learning and understanding. All children appeared to benefit equally well

within a mastery-oriented context. Performance-oriented children may be encouraged to persevere, explore and experiment more once the focus is removed from normative assessment.

A mastery orientation is based on the assumption that trying leads to succeeding and is part of a greater sense of self-efficacy (Ford, Smith, Weissbein, Gully, & Salas, 1998). Performance-oriented children can stop trying if an outcome becomes uncertain or they might choose less challenging tasks in order to guarantee success (Elliott & Dweck, 1988). It is also important to consider other influences within a learner's life when accommodating these different AGOs within a classroom. Influences are not just peers who are physically present; one's own expectations, previous experience, parental expectations and teaching context all play a role in forming learning motivation which adds to the difficulty of providing individually tailored support. Avoiding the possible maladaptive consequences of a performance orientation, such as a lack of perseverance, challenge avoidance and low intrinsic motivation (Church et al., 2001), may have greater success with a whole class mastery-oriented context. A whole class mastery-oriented context may serve to support both orientations by removing the focus on normative assessment and encouraging a "have a go" philosophy.

6.3 Paper 2

Metacognitive support needs to move beyond prompting learners that help is available to creating an atmosphere in which children feel able to pursue different learning strategies, request help and explore resources. A whole-class mastery-oriented approach may provide such an atmosphere as the predominant focus is on

the process of learning. Paper 2 focused on such an approach. The research presented in Paper 2 explores ways in which creativity and process-focused learning can enhance children's metacognitive reflection, competence valuations and motivation for mathematics. Children were encouraged to "*have a go*" and use each other as a resource for learning. Children were also encouraged to find their own method for solving mathematical problems, with a very clear focus on the process of problem-solving rather than purely on the outcome. Small-group discussions allowed the children to suggest what they thought they had learnt, to share ideas and to consolidate learning. Small group discussions also promoted the idea of metacognitive reflection and the value of sharing ideas with peers.

Ford et al (1998), measured metacognitive activity after a training program by asking participants to agree or disagree (using a scale) with statements such as "*I noticed where I made the most mistakes during practice and focused on improving these areas*". Their results link mastery orientation to metacognitive activity which in turn influences knowledge and skill acquisition as well as self-efficacy of the learner. Previous research has emphasised how perceived ability, or self-efficacy, can interact with a performance AGO and influence task choices and persistence (Elliott & Dweck, 1988). Research studies such as these suggest the importance of providing metacognitive support. The research presented in this thesis seeks to evaluate the benefits of inherent metacognitive support and a whole class mastery-oriented.

Paper 2 presents research in support of a mastery-oriented classroom context. Children, in groups of 3, contributed substantially more metacognitive reflections to a post-intervention interview than they had to a pre- interview. For example, a fairly

basic suggestion of *"we should work together"* became more specifically expressed as *"... listen to someone else's idea because you can add them together"*. Children also displayed significantly more mathematical methods on their post - intervention maths paper than they had on their pre-intervention maths paper, suggesting that they were attaching more significance to the process of problem-solving.

Paper 2 also suggested gender differences; girls' motivation for and perceived competence for maths showed an increase after the intervention. Boys maintained their views of both their perceived competence for maths as well as their motivation for maths as a subject both pre- and post-intervention. Harackiewicz & Barron (2000) suggest that mastery-oriented goals are linked to enjoyment and interest and these seem to be valuable characteristics to promote. Promoting these characteristics seems to be especially necessary in subjects such as mathematics, which can show gender differences continuing and increasing as children move through formal schooling. Eccles et al (1993) measured children's competence with questions such as *"How good in maths are you?"* and task belief valuations such as *"How much do you like doing math"*. Eccles et al (1993) found that gender specific views for maths were apparent from as young as 7 years. Boys tended to rate themselves as better at maths than girls rated themselves and girls valued maths the least. These results have important implications for the future choices of these children. If children continue with unchallenged competence and value beliefs and base their subject choices on these beliefs, then there will be a steady decline in females choosing maths and similar subjects as they progress in their education. Research such as this shows the importance of establishing and promoting a mastery-oriented focus early in a learner's academic life and creating a context in which effort is seen as a sign of competence.

Newman (2002), suggests that *“when teachers demonstrate that dilemmas and uncertainty can be tolerated - and perhaps shared.....students may realise that it is normal not to be able to solve all problems independently”* p. 136 (Newman, 2002). By providing a mastery-oriented context, teachers can promote sharing of uncertainty and dilemmas as a “normal” part of learning and can encourage reflection and problem-solving.

The two papers presented in this thesis highlight ways in which AGO can be supported individually through adaptive software and ways in which children can be supported to learn successfully within their classroom. The research presented in paper 1 investigates metacognitive support tailored for individual AGO and paper 2 investigates an environment in which children feel able to try out different methods suited to themselves and to value the learning process over just the outcome. Further research may need to consider the role of parental influence as well as classroom context and individual AGO. Expanding our qualitative interview method presented in Paper 1 to include a trichotomous framework of AGO approach and avoidance motivation would also allow consideration of further variables contributing to a child’s AGO such as confidence to continue and resilience to failure.

This research recognises that children apply different approaches to their learning and simply put, think differently about classroom tasks. Recognising and supporting these differences can enable children to gain the confidence in exploration without impinging on their perceived ability evaluation.

7.0 Reflective account

Two different research approaches have been presented within this thesis and as such both have interesting results to offer as well as some limitations. This section reflects on the strengths and limitations of each study and the thesis as a whole.

7.1 Role of the researcher

The researcher role within Paper 1 is a more traditional approach collecting quantitative data. The log system inherent within Ecolab II allowed for objective online data collection of each child's actions throughout their task. This method of data collection allowed the researcher to sit discreetly apart from the task. The children were able to continue with their task without additional aid from the researcher and in so doing possibly keep more within their typical classroom behaviour.

Paper 2 explored how knowledge of AGO can be applied within a classroom by creating a mastery-oriented context for mathematics. The researcher role for Paper 2 was more interwoven with the project; the researcher took an active part within the classroom during both the creative session and the formal maths sessions. The presence of the researcher in the classroom as part of the project may have encouraged the novelty of the creative approach and further reduced the sense of formal mathematics. This may have added an extra emphasis on a mastery-oriented context as children perceived the researcher (and visual artist) as holding different expectations to the teacher. This possibly gave the children greater license to explore and experiment.

The children's, teacher's and researcher's views of mathematics have been reflected in the design, implementation and write-up of the project and this has created a less objective study. Both studies focused on the process of the learner rather than outcome

and have attempted to track tasks from start to finish within a typical classroom environment.

Reflecting on the role of the researcher within each study may provide further insight into both the design and reporting of each data set. Taking account of possible researcher effects, such as children's perception of the researcher, adds to the understanding of each paper's results and can be used to inform future research design.

7.2 Reliability and Validity

The categorisation of children in paper 1 is an interesting feature of this study. Using scenarios to categorise children according to AGO has allowed for exploration of children's reasons behind their choices. This method has also allowed exploration of dispositional AGO, that held by individual children, rather than situational, or contextual AGO, that presented by classroom environment or task instruction (Harris et al., 2008). Presenting scenarios to children was to modify potential desirability bias on the part of the children as well as providing a realistic context which the children can relate to. The results are encouraging and consistent with the literature; however, due to the novelty of this approach, only tentative conclusions should be drawn from this study. Further research with the scenarios has since taken place using two coders. These categorised children independently and then calculated a measure of inter-rater reliability, which achieved a Kappa of 0.87 indicating good agreement and increased rigour (Bonnett, Yuill, Carr, Deane & Fredman, 2014).

A further possibility currently under investigation is an AGO scale so that children can be measured with multiple goals, for example a child may be high in mastery-orientation

and low in performance-orientation rather than solely mastery-oriented or solely performance-oriented. This may then also allow consideration of a 2 x 2 framework exploring both approach and avoidant dimensions of AGO.

Although parametric data analysis has been used in paper 1, the small sample size may be more appropriate for non-parametric analysis. For example, large variance in our data is evidenced in figure 3.4 when looking at clue choice associated with type of food chain and this makes it harder to draw firm conclusions. An alternative method may have been to take a case study approach and focus on particular AGO extremes. By its nature quantitative analysis loses some of the individual story behind the data, something Paper 2 attempted to convey with the metacognitive reflection. Using case studies would have reduced the amount of data, but would have allowed an in depth study of language used during a task to further explore children's motivation for pursuing a particular task.

Although Paper 2 suggests conclusions regarding the quantitative data collected, it is difficult to define the exact influences contributing to the change in pre and post maths scores. As suggested, it may have been the creative process itself, the increased maths focus, the presence of the researcher or additional peer cooperation. The metacognitive reflection however appears more reliable evidence of the impact of a mastery-orientated context. In the post-intervention interviews children appeared to have a developed view of themselves as learners and their place within the classroom. Becoming an active participant in each stage of the task appears to have created a greater understanding of the role of a learner. It is possible that the creativity and high-level of involvement of the task fostered a 'sense of belonging' discussed by Ames in which she describes children as being an 'important and active participant'(p. 263, Ames, 1992) and creating a connection with their

learning. It would have been interesting to also have categorised the children within this study to enable a measure of AGO difference and explore possible interactions between dispositional AGO and situational AGO. A mastery-orientation appears to provide a 'buffer' against difficulty (Newman, 1998) and further conclusions regarding this role may have been possible with individual categorisation of children.

7.3 Future Directions

A strength of this research is the use of typical classroom tasks and an exploration of process, rather than reliance upon an outcome measure. However, with changing variables between study 1 and study 2, and mixed method design, it is hard to draw firm conclusions. These studies represent an exploration of AGO within the classroom and more rigorous investigation is now required to quantify the impact of dispositional and situational AGO over time. As indicated in figure 6.1, children may achieve the same outcome in a task, but the learning process and possible understanding may be qualitatively different. This in turn would influence future goals, attainment and motivation.

This research suggests that children may adopt the same method, for example putting a hand up in class to ask a question, but with different underlying motivations. Similarly, Grant and Dweck (2003) state that children of either a mastery- or a performance-orientation may both have a similar focus and be motivated to gain a good grade, but it is the attributions and self-theories underlying this goal that creates resilience or obstacles for the child if all does not go according to plan. Taking a measure of children's self-theory, for example whether ability is fixed or malleable, would provide a useful measure to use alongside results such as those within this research. This would enable a fuller picture of children's learning to be drawn.

The role of AGO continues to be an interesting and varied area of research and whilst providing some insight into classroom behaviour, the research presented in this thesis also gives rise to further questions and directions.

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9.0 Appendices

9.1 Paper 1

9.1.1 Appendix 2: E Goals parental Consent Template

Does your child enjoy I.T. learning?

The E-Goals project, based at the University of Sussex, is looking at new and exciting ways to use technology to enhance learning strategies. Researchers from Sussex are visiting your child's class in the next few weeks to try out a task that involves children working individually with specially designed software. Ecolab II was designed to help children learn about food chains and webs, as part of the Key Stage 2 ecology curriculum. It is a fun, as well as informative, piece of software which children should enjoy using as well as being beneficial to national curriculum learning.

Children will take part in an initial session with the researcher followed by two 20 minute sessions using the software. We will then ask them to tell us what they thought of their experience. We expect the children to enjoy it, but they can only take part with your permission, and if they want to on the day: they are free to withdraw at any point in the research. If you would like more information, you can contact Nicola Yuill on 01273 678630; or Victoria Bonnett on 01273 678916 or email nicolay@sussex.ac.uk or v.m.bonnett@sussex.ac.uk.

The findings of the study will be used to develop software which encourages children to reflect on the type of help they may need, enabling development of their help-seeking skills.

Please complete and return to the class teacher as soon as possible:

Thank you

Please complete ***all parts*** and return to the class teacher as soon as possible:

I am happy for my child to take part in the science task being carried out by the University of Sussex. I understand that this will involve them being videoed, for use only by the research team.	Yes/No
I am also happy that video footage or stills of my child carrying out the above task may be used anonymously to describe the research to other researchers at meetings, conferences and in published work.	Yes/No
I am happy for video footage or stills of my child carrying out the task to be used anonymously on the project website (http://www.lifesci.sussex.ac.uk/research/chatlab/)	Yes/No

My child's name is _____

My child's class is _____

Signed (parent/carer)

9.1.2 Appendix 3: Head Checklist

Psychology Department, University of Sussex**Ethical checklist for working in schools**

All researchers are required to abide by ethical guidelines provided by the British Psychological Society when working in local schools. These cover in particular keeping data confidential, permitting children to withdraw and gaining appropriate consent. All work with children also has to gain approval from the Psychology Ethics committee. We would be grateful if you could check and sign the following sheet to show that you approve of the procedures chosen.

Names of researchers visiting the school: **Amanda Harris and Victoria Bonnett**

Supervisor and contact number/email: **Dr Nicola Yuill - nicolay@sussex.ac.uk**

Period of visits: **Autumn term** **Year 2008**

Classes/year groups visited: **Year 5 and Year 6**

Brief description of procedure

We will be assessing how children's achievement goals influence their help-seeking behaviour when using an educational software system called Ecolab. Ecolab was designed to help children learn about food chains and webs, as part of the Key Stage 2 ecology curriculum. The system has a learner model and a software scaffolding structure that can detect and respond to learners' behaviours. Previous evaluations of Ecolab II have shown it to be effective in promoting learning, particularly for low-ability children between the ages of 9 and 11 years.

Our study will involve 2 or 3 sessions with each child. In the first we will assess children's goal orientation and help-seeking profiles. Following this each child will have an individual software session on a laptop using the Ecolab II software. At the end of this session we will ask children for their feedback on the software. We may, for some children, do the software session in pairs and others individually.

Each child will have the right to withdraw from the study at any point without any further repercussions.

Our procedures have been cleared by the psychology department's ethics committee.

Consent procedure used:

☐ Opt-out (parent/carer given 1 weeks' written notice to opt out)

Police check required: yes and researchers have a current CRB certificate

Name of school **Herstmonceux C of E Primary School**

Head's signature..... Date

9.1.3 Appendix 4: AGO response sheet

Kar2ouche:-**Scenario 1 : Child 1**

What do you think _____ thinks about this task?

How do you think she/ he feels about doing it?

*Why does he / she want to do well?**What would happen if he / she found this activity hard?***Scenario 1 : Child 2**

What do you think _____ thinks about this task?

How do you think she/ he feels about doing it?

Why does he / she want to do well?

What would happen if he / she found this activity hard?

What do you think about this task?

What would you do if you found this activity hard?

Scenario 2 : Child 1

Which do you think _____ would choose?

How do you think he / she feels about doing this task?

Why does he / she want to do well?

What would happen if he / she found this activity hard?

Scenario 2 : Child 2

Which do you think _____ would choose?

How do you think he / she feels about doing this task?

Why does he / she want to do well?

What would happen if he / she found this activity hard?

Which one do you think you would choose?

What would you do if you found this activity hard?

Do you think you are like either *name child* ?

Why is that?

9.2 Paper 2

9.2.1 Appendix 1: Formal Maths Questions

Plant pot

Your pot is going to be made out of 6 plywood rectangles. Each rectangle will measure 20cm x 45 cm. Plywood is sold in 100 x 100cm squares. How many pieces of plywood will you need to buy to make your pot?

Your pot is going to be made out of 6 plywood rectangles. Each rectangle will measure 20cm x 45 cm. Each piece of plywood will need 4 holes drilled in it to attach the wire. How many holes will need to be drilled in total?

Your pot is going to be made out of 6 plywood rectangles. Each rectangle will measure 20cm x 45 cm. To attach the pieces of plywood together you are going to use wire. How much wire will you need to go around the whole hexagon? How much would you need to go around twice?

Your pot will take three sessions of 2 hours to make with 12 people. How long would it take one person to make the pot?

Alien bin

Your bin will be made out of a cylinder of material. The material needs to be 65cm x 160 cm. Fabric is sold in 100cm x 100cm squares. How many squares will you need to buy to have enough material? How much material will be left over?

Your alien will have 8 legs. These will be made from 10cm x 50 cm rectangles. How much fabric will you need to create 8 legs? How much would you need to create 16 legs?

Your bin will have a 160 cm circumference. You will need to attach blobs of skin around the whole circumference. If each blob measures 10 cm x 10 cm, how many blobs will you need to cover the circumference of the bin?

Fabric comes in 1.2 metre strips. How many strips will you need to buy to have enough blobs?

Your alien will take three sessions of 2 hours to make with 12 people. How long would it take one person to make the pot?